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# QUARTERLY
OF THE

# NATIONAL FIRE PROTECTION ASSOCIATION

*"To Promote the Science and Improve the Methods of Fire Protection and Prevention."*

PUBLISHED QUARTERLY AT BOSTON, MASS., BY THE
NATIONAL FIRE PROTECTION ASSOCIATION

Printed in U. S. A.

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Vol. 35 July, 1941 No. 1

# QUARTERLY

OF THE

# National Fire Protection Association

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# National Fire Protection Association

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A NON-PROFIT TECHNICAL AND EDUCATIONAL ORGANIZATION

*To promote the science and improve the methods of fire protection and prevention.*

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Western Canada Insurance Underwriters' Association.
Western Factory Insurance Association.
Western Sprinkled Risk Association.
Western Underwriters Association.
West Virginia Fire Underwriters' Association.
West Virginia Inspection Bureau.

# Table of Contents.


London Fog ..... Frontispiece

Editorials ..... 5

Meetings of Board of Directors ..... 8

Safeguarding Defense Industry. *Robert S. Moulton* ..... 14

Aviation Fire Protection. *Fred H. Grieme* ..... 21

Age of Municipal Fire Apparatus. *Warren Y. Kimball* ..... 31

Forest Fire and National Defense. *David P. Godwin* ..... 33

Dust Explosion Hazards of Powdered Metals. *Hylton R. Brown* ..... 43

Artillery Ammunition Manufacture. *Arthur B. Guise and J. S. Slicer, Jr.* ..... 52

Marshfield, Mass., Conflagration. *P. C. Charnock* ..... 71

The Plymouth Rubber Co. Fire ..... 74

St. John, N. B., Group Fire. *C. F. Clarkson* ..... 75

Philadelphia Lumber Yard Fire ..... 78

Wheeling Machine Products Company Fire ..... 80

Jersey City Waterfront Fire. *Wm. G. Hayne* ..... 83

Jacksonville Pier Fire ..... 93

San Pedro Wharf Fire ..... 94

Fires in Which There Was Loss of Life ..... 95


*Reports of fires appearing in the Quarterly are copies of or extracts from written reports forwarded to the Association. This Association, as a body, is not responsible for the statements or opinions of any of its members.*

*British Combine.*

**London Fog.**

# The Quarterly

Vol. 35 July, 1941 No. 1

**The 1941 Annual Meeting.** The 45th Annual Meeting of the Association held in Toronto, May 12 to 16, was a memorable event. Members from the states returning to Canada after a lapse of ten years since the last N.F.P.A. meeting in Toronto, renewed their friendships with Canadian members and again enjoyed the cordial hospitality of our Canadian hosts.

The meeting featured many interesting talks on defense against fire due to incendiary bombs and sabotage. Because of the nature of the information presented, it is not possible to publish it all, but the main features are included in the Proceedings printed as Part 2 of this QUARTERLY.

The Proceedings this year do not contain the preprinted reports of committees which were circulated to all members in the volume of Advance Reports which was issued as Part 2 of the April QUARTERLY. There seems to be no necessity of duplicating material that is already in members' files, particularly as the various standards adopted will in due course be made available to all members in separate pamphlet form incorporating all revisions. The Proceedings contain a record of action taken on the various committee reports, including notation of all amendments made.

* * * * *

**Fire Protection in Defense Plants.** The Defense Plant Corporation, the U. S. Government agency that finances the new plants being erected for munitions production, has taken a very constructive step in requiring proper fire protection during the construction of plants. This forward-looking Government agency, on the advice of Major Carl G. Richmond (member N.F.P.A.) of the War Department office, has arranged for the inclusion in all future contracts for the construction of defense plants of clauses providing for installation of fire protection as the work progresses. This is in recognition of the great importance that there be no fires during construction that may delay future production, and in appreciation of the fact that in defense plants, insurance coverage during the construction period will not prevent delay in case of fire. The following provisions are accordingly to be included in Defense Plant Corporation contracts:

> "There shall be no delay in the installation of fire protection equipment. Hydrant protection shall be made available as soon as combustible (temporary or permanent) material accumulates, the loss of which, by fire, would delay the construction program.

"All underground water mains for fire protection and all hydrants and hose house equipment required by the contract shall be installed, completed and made available for permanent use not later than the time at which 30% of the construction program shall have been completed.

"If automatic sprinkler protection is required as a part of the contract, the installation shall follow closely the completion of roofs and shall be made in a manner and at a time to provide protection before any appreciable volume of machinery or other equipment is moved into the buildings. Where automatic sprinkler protection is not provided for and where combustible material exists adequate first aid protection equipment shall be maintained during the construction period."

* * * * *

**Standardization of Hose Couplings.** The need for interchangeability of hose threads between the fire apparatus of neighboring communities is receiving widespread attention under the stimulus of national defense plans. The greater part of the area of the United States is already standardized as a result of a movement initiated by the N.F.P.A. years ago and actively promoted by the various regional insurance inspection and rating bureaus. Some of the older large cities, particularly in the East, are still not standardized. Cleveland is now converting its hose couplings to national standard so as to provide interchangeability with equipment in the surrounding areas.

In Virginia, the majority of communities have national standard couplings, but there are still a number which do not. The Virginia Fire Mobilization Committee says: "We feel that this is very important and that each community that does not have the U. S. Standard insist on their buying all new hose with U. S. Standard thread couplings and have enough adapters available that they can use to couple the old hose to the new hose until such time as it will be possible for them to change fire hydrants over to standard. We shall insist on each fire department in the various zones having the necessary adapters to make it possible to go into any community and use their pumpers as well as their hose without any delay in making couplings."

Canada has a wide variety of couplings, except in the province of Quebec where much progress toward uniformity has been made. The lack of any uniform standard complicates protection problems, particularly for airports and other military establishments outside of cities and towns where there may be need for interconnection with the equipment from a number of different communities. During the Toronto meeting, a number of Canadian N.F.P.A. members expressed interest and the hope that a movement might be initiated to standardize all hose couplings in Canada, preferably adopting the U. S. national standard so as to permit mutual assistance across the line in case of necessity and to standardize manufacturing practices in the two countries.

**London of the Future.** "London of the Future" is the title of a Bulletin from Britain, published recently by the British Library of Information. While each day a few more London streets, a few more British homes are lost in the avalanche of fire and bombs from a German sky, there are those who find themselves looking upon this wanton destruction with more than a feeling of unmitigated horror and vexation. They are the British architects and city planners and engineers who are thinking ahead and dreaming of the day when there will be a new London to build.

The plans are already under way. They will be completed and presented to the British public during the winter of 1942. Speaking of these plans, and more specifically about the buildings of the London of the future, Captain W. H. Ansell, President of the Royal Institute of British Architects, says that they will be "scientifically constructed and *fire-resisting*."

Once before in 1666 when London was leveled to the ground (that time, however, during a peace-time fire "blitz"), a chance to rebuild the city with an eye toward fire protection was lost. It probably should not have been lost had the science of fire protection been known or understood. Nevertheless, the British were quick to learn. The outcome of the Great Fire was the founding of fire insurance, and the introduction of elementary steps for fire protection.

Since 1666, there have been many and great fires in London, but none so great and so utterly devastating as that Great Fire. And now that London is suffering its worst catastrophe since 1666, it appears that measures are going to be taken when it is all over to rebuild a city that can never again suffer fire of any magnitude. The London of the future, according to reports received thus far, should be the dream of every fire protection engineer.

* * * * *

**Personal Liability.** On June 21, 1939, seven persons lost their lives when fire swept through a New York tenement. Several perished when flames from the unprotected window openings trapped them on the outside balcony fire escapes which had been substituted for proper interior exits. The owner of this tenement was recently convicted of manslaughter and sentenced to 3 to 6 years imprisonment for failure to make certain alterations called for by the Multiple Dwelling Law. In the case of the People vs. Leo. J. Alexander it was urged that failure to make the necessary alterations called for by the law contributed to and resulted in the fatalities. Prior to the trial of this case, the defendants in two other cases were convicted of manslaughter under similar circumstances, but the conviction of Alexander by jury was the first case of its kind in the state of New York. This case may prove to be a stimulus to the principle of personal liability for fires due to negligence which has been urged for many years by the National Fire Protection Association.

# Meetings of Board of Directors.

## Toronto, May 13, 1941.

**Present.**

Albert T. Bell, Chairman
Alvah Small, President
David J. Price, Vice-President
Richard E. Vernor, Vice-President
George W. Elliott, Past President
Percy Bugbee, General Manager

A. L. Brown
Frank A. Epps
Russell Grinnell
C. C. Johnson
C. W. Johnson
Harold L. Miner
C. W. Pierce
W. J. Scott
H. Sidney Smith
Leon A. Watson
Lloyd T. Wheeler
John L. Wilds

**Business Transacted.**

1. The report of the Chairman of the Board to the annual meeting was read and approved.

2. The report of the Treasurer was approved.

3. It was unanimously voted to recommend to the members at the first session of the annual meeting the election to Honorary Life Membership of Mr. George W. Booth, Chief Engineer of the National Board of Fire Underwriters.

4. It was voted to hold the next meeting of the Board in Boston on Monday, June 23, 1941.

5. The request of Chairman Halpin of the Committee on Public Water Supplies for Private Fire Protection for permission to present a report to the annual meeting was approved.

6. It was voted to recommend to the Resolutions Committee that a congratulatory resolution respecting the seventy-fifth anniversary of the National Board of Fire Underwriters be prepared and presented to the annual meeting.

7. President Small asked the Board for an opinion as to whether the Committee on Laws and Ordinances or the Special Committee for Drafting a Model Electrical Law had jurisdiction over the model law for electrical inspection to be presented at the annual meeting.

The Board unanimously ruled that the Committee on Laws and Ordinances had jurisdiction.

## Boston, June 23, 1941.

**Present.**

Albert T. Bell, Chairman
Alvah Small, President
David J. Price, Vice-President
Hovey T. Freeman, Secretary-Treasurer
George W. Elliott, Past President

A. L. Brown
H. T. Cartlidge
Frank A. Epps
Russell Grinnell
C. W. Johnson
W. E. Mallalieu
H. L. Miner
C. W. Pierce
H. Sidney Smith
W. C. Wagner
Leon A. Watson
Lloyd T. Wheeler

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N.F.P.A. Staff: Percy Bugbee, General Manager, Robert S. Moulton, Technical Secretary, Horatio Bond, Chief Engineer.

**Business Transacted.**

1. The following members were elected officers of the Corporation for the year 1941-42: President — Alvah Small; Vice-President — David J. Price; Vice-President — Richard E. Vernor; Secretary-Treasurer — Hovey T. Freeman; Chairman, Board of Directors — Albert T. Bell.

2. The Advisory Committee for 1941-42 was reappointed as follows: Albert T. Bell, Chairman; Alvah Small; David J. Price; Richard E. Vernor; Hovey T. Freeman; C. W. Pierce.

3. Messrs. C. W. Pierce and John L. Wilds were selected to complete the Nominating Committee for 1942.

4. It was voted to hold the 46th annual meeting in Atlantic City May 11-15, 1942. It was agreed as the sense of the meeting that the 1943 annual meeting should be held in the West.

5. The recommendations of the 1941 Nominating Committee relative to holding annual meetings in the West and South or holding regional meetings (see report of Nominating Committee as printed in Proceedings) were referred to the Advisory Committee.

6. The Program Committee for the 1942 annual meeting was appointed as follows: the President, the Chairman of the Board of Directors, and the General Manager.

7. The Budget for 1941-42 as prepared by the General Manager and recommended by the Finance Committee was approved.

8. A proposed resolution relative to the possible exemption of firemen from compulsory military service as referred to the Board by the annual meeting (see Proceedings) was tabled.

9. It was voted to suspend all N.F.P.A. memberships in Axis and Axis-occupied countries and to hold dues payments from such members pending the termination of the present emergency.

10. Proposals by President Small and comments thereon by the N.F.P.A. staff referring to a change in policy for the QUARTERLY and other N.F.P.A. publications were referred to the Advisory Committee for consideration as their first item of business and report with recommendations to the next meeting of the Board.

11. The General Manager reported current developments in coöperation with the General Federation of Women's Clubs in respect to the more intensive promotion of a general program of home fire safety. Various suggestions on this subject were referred to the Committee on Fire Safety in Homes and Small Properties.

12 (*a*). Amendments in the Table of Common Hazardous Chemicals recommended by the Committee on Hazardous Chemicals and Explosives, with the concurrence of the coöperating committee of the American Chemical Society, were adopted in accordance with the authorization of the annual meeting. (The text of these changes appears in the Proceedings.)

(*b*) The Committee on Special Extinguishing Systems reported that it had been unable to date to secure agreement upon the proposed modification of requirements for the strength of piping for low-pressure carbon dioxide systems as referred to the committee by the annual meeting for report to the Board. In view of the importance of carbon dioxide protection in certain defense industries and the desirability of conserving the use of steel for defense purposes, it was voted to authorize the Committee on Special Extinguishing Systems to submit to the Board for approval by letter ballot changes in the piping requirements in the standards on Carbon Dioxide Extinguishing Systems in the event that the committee secures agreement on this subject prior to the next meeting of the Board.

(*c*) Amendments to the 1941 report of the Committee on Static Electricity, as referred to the committee by the annual meeting for submission to the Board, were approved. (The text of these changes appears in the Proceedings.)

(*d*) A complete revision of the portion of the 1941 report of the Committee on Tanks dealing with welding was adopted on recommendation of the committee in accordance with the authorization of the annual meeting, with the deletion of specific references to locations subject to unusual wind velocities, thus making the provisions for strength of towers uniform for all locations. (The revised text appears in the Proceedings.) Chairman A. L. Brown of this committee reported a plan to meet certain criticism of the revised treat-

ment by the preparation of a separate pamphlet dealing with welding procedures as an advisory guide for inspection authorities. This plan was approved.

13. Mr. Alvah Small, reporting as Chairman of the Electrical Committee, summarized the action taken by the committee at a meeting held on June 10 and 11 and presented to the Board the several recommendations for action as made at the committee meeting. The Board took action on these matters as follows:

(*a*) The plan of the Electrical Committee to adopt as a regular routine the triennial revision of the National Electrical Code was approved.

(*b*) The action of the committee in adopting as its standard for a tamper-resisting and interchangeable so-called Type S fuse the dimensional characteristics of the present fuse of the Bussmann Manufacturing Company was approved, subject to satisfactory completion of the agreement of the Bussmann Manufacturing Company to make its patent covering this fuse design generally available to all manufacturers without royalty. It was voted to accept Chairman Small's recommendation that the necessary formalities for the release of a license to manufacturers include mention of the National Fire Protection Association, subject to provisions to avoid any legal liability on the part of the N.F.P.A.

(*c*) On recommendation of the Electrical Committee, it was voted to assent to the simplified practice on wire sizes proposed by the U. S. Department of Commerce.

(*d*) Chairman Small reported a request by the Electrical Committee for reconsideration of the proposal that reciprocal contacts be established between the Electrical Committee and the committee responsible for the Canadian Electrical Code, which proposal had at the January 18, 1941, meeting of the Board been tabled pending clarification of the international situation. After discussion it was voted to take no further action.

(*e*) Chairman Small reported the appointment by the Electrical Committee of special subcommittees to consider the electrical matters in the 1941 reports of the Committee on Static Electricity and the Committee on Gases. He further reported the recommendation of the Electrical Committee for consideration by the Board of the establishment of some procedure for the correlation of inter-related technical committee activities. This recommendation was referred to the Committee on Technical Committee Procedure.

14. The report of the Committee on Technical Committee Procedure was adopted, including action on the following items:

(*a*) The committee reported that the changes in the membership of the Electrical Committee and the statement of policy relative to limiting the size of the committee adopted by the Board at its last meeting had been generally accepted. A communication from the Pacific Coast Electrical Association re-

questing reconsideration of the negative decision of the Board on their request for representation was considered without action. The Committee on Technical Committee Procedure also reported, without recommendation, its further consideration of possible reductions in delegations of some of the groups that now have multiple representation on the Electrical Committee.

(*b*) The technical committee appointments recommended by the committee were confirmed. The Committee on Technical Committee Procedure was authorized to fill vacancies in the chairmanship of the Committee on Construction Operations caused by the retirement of Mr. William B. White, in the Committee on Protection Against Lightning due to the death of Dr. Morton G. Lloyd, and in the Committee on Air Conditioning due to the resignation of Mr. Carl W. Wheelock; also to make other committee appointments that may be indicated by developments prior to the printing of the 1941 Year Book, subject to confirmation by the Board at its next meeting.

(*c*) In view of the recent adoption by the Electrical Committee of revised rules of procedure and the existence of rules of procedure of the American Standards Association which affect the operations of the Electrical Committee and other N.F.P.A. committees functioning as sectional committees of the A.S.A., it was voted to amend Par. 63 of the Regulations on Technical Committee Procedure by adding to the final sentence which now reads: "In no case shall any one individual have more than one vote at a meeting of a committee" the following: "except in committees operating as Sectional Committees of the American Standards Association where, in accordance with A.S.A. procedure, one individual is appointed as representative of more than one organization."

(*d*) Consideration was given to the proposed organization of a Committee on Building Code Requirements for Fire Protection and Fire Resistance under the program of the Building Code Correlating Committee of the American Standards Association under the joint sponsorship of the National Fire Protection Association, the National Board of Fire Underwriters, and the National Bureau of Standards. It was voted to decline to approve the committee organization submitted to the N.F.P.A. by the A.S.A. office on the ground that the proposed organization was neither equitably representative nor likely to be conducive to efficient committee work.

15. On recommendation of the Advisory Committee, it was voted to suspend the Committee on Articles of Association and transfer its functions to the Board of Directors. President Small was authorized to approve changes in the personnel of the Membership Committee and other non-technical committees subject to confirmation by the Board at its next meeting.

16. On behalf of Board member J. L. Wilds, General Manager Bugbee presented a progress report on the proposed research on fire gases, indicating

that active research on this subject was to be inaugurated at the Massachusetts Institute of Technology under a research fellowship program beginning with the next school year.

17. Chief Engineer Bond reported on staff activities in connection with national defense, discussing "Fire Defense" and other publications issued for the purpose of making information on this subject generally available. He reported on contacts with federal, state and local authorities and discussed plans for the coördination of activities of N.F.P.A. members and others in the interest of safeguarding essential production facilities, storage of materials, and the general public interest. This report was approved and it was voted to instruct the staff to continue its activities in this field.

18. A communication from Mr. Benjamin Richards relative to the procedure of technical committees, with particular reference to the amending of reports subsequent to their preprinting for circulation to the membership, was referred to the Committee on Technical Committee Procedure.

A communication from Mr. William F. Steffens relative to the charging of a registration fee at annual meetings was referred to the Advisory Committee for consideration and report at the next meeting of the Board.

19. A memorandum from Chairman Bell relative to the method of operation of sections of the Association was considered without action.

It was voted to express to Mr. Carl W. Wheelock the appreciation of the Board for his conscientious and effective service as Chairman of the Committee on Air Conditioning.

Comments by Mr. Cartlidge as to the time of the June meetings of the Board were referred to the Advisory Committee.

# Safeguarding Defense Industry.

By Robert S. Moulton.

American industry, or at least that part of it represented in the N.F.P.A. membership, is definitely thinking about protection from fire in the present national emergency. This is the conclusion reached from hundreds of letters from industrial members sent to the N.F.P.A. Executive Office and from the remarks of many plant fire protection men present at the annual meeting of the National Fire Protection Association in Toronto.

All of the problems of normal peace time fire protection are intensified in the present emergency. Maintenance of continuity of production is the major objective. In many critical industries the monetary loss due to fire may be of minor importance compared with the interruption to production which any major fire entails, particularly at the present time when the replacement of machinery, materials and equipment may involve long delays. The normal fire hazards of industry are multiplied in proportion to increased production and hours of factory operation. In addition, there is the threat of fire due to sabotage or airplane bombing. N.F.P.A. members generally recognize these hazards and have practically all taken some steps to meet them. The measures employed vary widely, depending upon the size, character and importance of the property, and the available fire protection facilities. Some industrial executives, to be sure, do not as yet understand the importance of fire protection. Some plants seem content to guard against sabotage by placing a fence around the plant, with no further thought for protection. The great majority, however, have given their special problems earnest attention, and while there is still much to be done in the individual plants in order to secure adequate fire safety, most seem to appreciate the existence of the fire protection problem and to be thinking constructively about it and instituting fire protection measures as opportunity presents. What is being done as summarized in letters received by the N.F.P.A. Executive Office is far too extensive to be described in any complete detail. Some of the information received is of a confidential nature and cannot be published, but there is enough information available to give a good overall picture of what industry is doing in the present emergency.

The industrial plants with good peace time protection are generally pretty well equipped to meet the present emergency. In such cases measures must be taken to guard against some new hazards and any extra precautions are merely superimposed upon the existing fire protection set-up without the need of any radical change in organization or any very heavy expense for equipment. In

the words of N.F.P.A. Member James J. Duggan of the South Charleston, W. Va., plant of the Carbide and Carbon Chemicals Corporation, "It is our opinion that the vast majority of so-called 'extra' precautionary measures should be taken regardless of whether the country is at peace or war." This plant is typical of many plants engaged in the production of materials vital to the national defense effort where a previously organized fire protection staff has been able without undue difficulty or prohibitive expense to supplement existing fire protection facilities with such extra features as are deemed necessary in the present emergency. The Fire Prevention Department of the Endicott Johnson Company is another interesting example of effectively organized fire protection in a different type of industry. Chief J. R. Eldridge reports that in the 27 plants of his company he has a uniformed force of 113 full paid men. An inspection system functions regularly to detect and safeguard hazards. All buildings are equipped with automatic sprinklers which are supervised through a rigidly established procedure and all possible measures are taken to prevent fire and to control in its incipiency any fire which does occur.

The Eastman Kodak Company is another leader in the field of fire protection with a well-organized fire protection program under the direction of N.F.P.A. Member Allen L. Cobb. Many features of the design of the fire protection system in Kodak Park, Rochester, N. Y., which were laid out for peace time reliability also serve excellently to minimize the danger of interruption of fire protection due to sabotage or bombing. For example, this plant has its own water system, independent of the city supply, with two separate power sources either one of which is adequate to supply water for automatic sprinklers or hose streams should the other be deranged. Beyond the necessity of the very careful identification system of employees to prevent the access of unauthorized persons, and a few other specific provisions, the peace time fire protection system seems reasonably adequate for the present emergency. Typical of the special precautionary measures now instituted is having constantly in the plant a box car loaded with sand bags and truck facilities available so that sand bags can be quickly brought to any point where a bomb may be discovered. Arrangements have been made with the Rochester Police Department so that their bomb squad will be called if any suspicious package is found.

Another N.F.P.A. member who has provided an excellent detailed report of his current fire protection program is F. Bostwick, Director of Fire Prevention of the Briggs Manufacturing Company. The program of this company emphasizes the importance of a systematic procedure for assuring that automatic sprinklers and other fire protection valves are always open. This is of particular importance at the present time because, in addition to the possibility of accidental closing of valves, there is now the danger of malicious valve closing as a prelude to war incendiarism. Regular inspection procedure checks

all valves twice every 24 hours, with an added inspection every Monday morning. The fire inspector is the only person allowed to open or close any valves controlling any part of the sprinkler system. Fire inspectors are constantly on duty.

The General Motors Corporation is another large concern which has a well-established fire protection program throughout its many plants and subsidiary enterprises. Illustrative of the importance placed on fire prevention by the General Motors management, the men in charge of fire protection at a considerable number of their important plants attended the N.F.P.A. annual meeting in Toronto to get first hand contact with the latest developments in fire prevention and fire protection. This company recognizes the importance of restricting fire areas to the minimum so that a fire which for any reason does start and spread beyond control will only destroy a restricted part of the entire plant. In the case of automobile and similar manufacturing, however, mass production with interlocking conveyor systems interferes with the segregation of areas and extra precautions in fire extinguishing facilities are accordingly employed.

The Westinghouse Electric and Manufacturing Company has a comprehensive fire prevention program extending throughout its many plants. Like other concerns, this company has plant fire brigades, well organized, so that men will be available on all three shifts. Special provisions are made for personal photographic identification badges for employees and an adequate system of fencing, flood lighting and guards prevents the access of unauthorized persons.

The present emergency has emphasized the importance and responsibility of the guard or watchman, particularly in plants having important defense contracts. The old idea of employing for this service men who by reason of age or mental or physical infirmity are incapable of other work is rapidly giving way to the idea of employing alert, able-bodied, fully intelligent guards and watchmen who can appreciate the importance of their responsibilities and do a competent job. For example, Mr. C. A. Ring of the Studebaker Corporation, South Bend, Ind., reports that in order to be considered for employment as a plant protection man for this company a man must have had at least a full high school education. A considerable number of college graduates are on this payroll.

Realizing the importance of coöperation between plant fire brigades and city fire departments, many forward-looking concerns have made prearranged plans with the city fire department so that the city firemen, if called into the plant, will understand the special hazards and will know the best fire fighting procedure. As an example of this, the Allis-Chalmers Manufacturing Company of Milwaukee reports that their volunteer fire department always works with the city department and that once every year all the city firemen make a trip

through the plant so as to become better acquainted with the buildings and equipment.

Many other outstanding examples might be cited from N.F.P.A. members in various branches of industry, utilities, transportation, etc., but the lack of space precludes mention of all of the excellent measures taken in the various plants.

Of all the plants which have made information on their current fire protection programs available to the N.F.P.A. Executive Office, the Lynn, Mass., plant of the General Electric Company is outstanding. Early this year Plant Engineer J. C. Trudinger began to give very serious consideration to the special problems of protection which might be involved in the event of enemy attack from the air and instituted a careful engineering study to see what should be done in the emergency to extend the previously existing, well-organized fire protection system in this plant. Mr. Trudinger realized that the northeastern section of the country furnished the nearest target for bombers from overseas and knowing the large amount of vital defense production in this particular plant it might well be made the first objective of any bombing raid. Two men, Robert C. Thompson, and W. H. Diddlebock, were assigned to make a full time study and put a comprehensive plan into effect. With no precedent except the British experience, this entire plan had to start from scratch and is not as yet fully developed, although measures already taken go far beyond those in effect in most industrial plants.

The Lynn plant of the General Electric Company, engaged in a considerable variety of important defense work, now employs some 15,000 people. It is spread over a hundred acres with 25 or more main manufacturing buildings and many subsidiary structures. For years the plant has had a well-organized plant fire department with two paid men on duty for each shift, supplemented by a volunteer or call force of some 85 men distributed between the various shifts so an adequate complement of fire fighters will be available at all times. This regular permanent force is now being supplemented by auxiliary plant firemen. A force of 150 auxiliary firemen has already been trained and this is to be augmented by another 100 to 150 men. These men volunteer for this service and are regularly drilled and instructed in fire fighting technique. They are given regular training in hose and ladder evolutions, handling extinguishers and other special training. This auxiliary fire force is for emergency duty in case of air raid and it is not expected that it would be called out in case of an ordinary plant fire which could be handled by the regular force. However, any of the auxiliary firemen who happen to be present when a fire starts would naturally be expected to assist. And since the auxiliaries have been carefully selected so that they will be distributed throughout all important buildings on all three shifts, it may be expected that one or two of the auxiliary firemen will be around when any fire starts.

In addition to auxiliary firemen, there is also being organized an auxiliary guard or police force, a salvage company, a first aid group, a squad to handle water, gas, steam and other valves in case of any break in piping, and various other special service groups. Some 2000 out of the total 15,000 employees of the plant have volunteered for one or another type of special service and it is expected that this number may be materially augmented before the program is complete. These volunteer auxiliaries have special identifying buttons to wear as a badge of office. It is felt that this is important to maintain their interest. A continuing program of drills and instruction is planned to keep all of the several groups of volunteers interested and efficient.

Messrs. Trudinger, Diddlebock and Thompson have given careful study to the type of possible attack which may be anticipated in order to plan protection accordingly. Their conclusion is that large-scale mass bombings such as those which British cities have suffered are extremely unlikely if not impossible at the present time in North American cities. They do feel, however, that it is important to provide protection against possible incendiary bombing attacks by relatively small groups of planes. Their protection program, while not disregarding the possibility of high explosive or gas bombs, is primarily designed to meet the more probable menace of incendiary bombing.

The auxiliary plant firemen are organized so that upon an air raid alarm each will at once proceed to his assigned station. Roof spotters are assigned to all important buildings — one, two or three men, depending upon the size of the building. While most of the roofs are of substantial reinforced concrete, some are ordinary plank roofs which it is thought bombs might penetrate, and in such buildings men have regular assignments to handle any incendiary bombs which might go through the roof. There is also a comprehensive organization for the safety of employees, with supervisors and monitors stationed in all stairways and other exits to assure the prompt and orderly evacuation of any areas that may be affected, to direct employees to alternate exits in case the usual exits are unavailable, to maintain discipline, and prevent panic.

In view of an estimated maximum 15-minute duration of any bombing raid, it is contemplated in this plant to handle any necessary blackout by shutting off lights and stopping production, rather than instituting the costly measures necessary to continue operation at night. Many of the buildings have large window areas and a very considerable expense would be involved in providing for continuing manufacturing operations during a blackout. Such special precautions will, however, be instituted in the case of certain manufacturing operations which must be continuous and which cannot be shut down without prohibitive loss. Emergency communications at this plant do not rely wholly on the telephone system, which it is felt might be subject to damage from bombing or sabotage. A comprehensive system of radio communication resembling a modern police department system assures emergency communica-

tion between principal points and the proper mobilization and direction of all the auxiliary forces in case of any emergency.

This entire program of the Lynn plant of the General Electric Company is being put into effect with a minimum of additional expense. The plant was already well protected with adequate water supplies, automatic sprinklers, special extinguishing equipment and other features of protection that had been developed over a long period of years when the management was giving constant attention to fire safety. Now it is found that little additional equipment is needed in the present emergency. Special extinguishing powder for magnesium bombs has been provided, certain pumping facilities have been strengthened, and a few other special measures taken, but no major expense has been necessary. The main feature of this program has been securing the coöperation of employees and training them for special duties so that in case the need ever does come the entire personnel of the plant will function as a coherent, well-disciplined organization to minimize any possible loss of life or property or of production facilities.

## Underwriters' Laboratories' Trailers.

Trailers equipped with air conditioning units, loud speaker systems, fluorescent lighting, compressed gas systems, and complete electrical testing equipment have replaced the well-known Underwriters' Laboratories' "red trucks" which have toured the country for the past five and one-half years. Two of these ultra-modern trailers are now on the road and a third will start out in a few weeks time. One unit is touring the East, the second the Far West, and the third will cover the Mid-west.

The work of these traveling laboratories has met with such great success in the past that it will be expanded with the new units. In addition to testing "on the spot" Underwriters' Laboratories approved fuses, wire, cables, and other electrical products secured from retail stores, local jobbers, and contractors, engineers in charge of the trailers will now call on city officials, electrical and building inspectors, insurance rating bureaus and inspection departments, fire chiefs, and fire marshals and at manufacturers' plants. The units will be available for displays and demonstrations and the engineers in charge will be qualified to talk on Underwriters' Laboratories activities.

These mobile units will continue to purchase samples of approved products on the open market and send them back to Chicago for countercheck tests to supplement the regular inspection which is being carried on continuously. During the last five years, 10,000 market samples have been bought and sent to Chicago, 15,000 samples have been tested and 200,000 miles have been

**(Above) One of the new ultra-modern trailers which have replaced Underwriters' Laboratories' "red trucks." Two of these mobile units are already touring the country, making "on the spot" tests of approved electrical equipment. (Left) Some of the special testing apparatus with which the trailers are provided. An audience can be accommodated on the inside while tests and demonstrations are in progress. Large windows and loud speaker systems make it possible for those on the outside to enjoy the show also.**

traveled by these laboratories-on-wheels. They have visited chief cities in nearly all states.

In construction, the new trailers exceed every known safety requirement and comply in every respect with the National Electrical Code. A small group of persons can be accommodated inside while tests and demonstrations are carried on. The large windows and address system make it possible to reach a much larger audience on the outside.

The air conditioning was installed when it was found that working inside the trucks was difficult in some sections of the country in the summer time. The fluorescent lighting system is probably the first that has ever been installed in a portable unit. Interior equipment consists of tensile strength machines, propane gas systems conforming to Underwriters' Laboratories' specifications, and micrometers and other tools for making detailed examinations of wire and cords of all kinds.

Other equipment is arranged for rating, blowing time, and temperature tests on cartridges, and plug fuses. Calibration and overload tests on circuit breakers can also be made.

# Aviation Fire Protection.

By Fred H. Grieme,
Civil Aeronautics Administration.

The use of aircraft in modern warfare, the destructive bombardments by explosives and incendiary bombs have forcefully impressed upon us the urgent and growing necessity for improved and more adequate industrial defense and air commerce facility protection. As it has been very ably stated in the recent book Fire Defense issued by the National Fire Protection Association, fire prevention is something more than posting a "No Smoking" sign, or providing extinguishers and throwing water. We are convinced that the importance of research in connection with fire protection, long range planning and educational work cannot be overemphasized.

The rapid development of air commerce and air defense in recent years has created many conditions which offer new problems from the standpoint of fire protection and which seem to call for special consideration and readjustment of the procedures and appliances we have used in the past. Airports have increased in size and the trend is towards still larger facilities to accommodate the ever-increasing air traffic densities. Airport buildings such as hangars have increased in size, especially in height, with tremendous door openings and artificial ventilating systems — all these factors having a definite bearing on fire protection equipment. Increased shop space and storage facilities for flammable materials are being provided in or near airport buildings. The increase in size, speed, fuel and oil capacities of aircraft during recent years, the difference in construction and materials used in these airplanes, the large number of aircraft now stored at airports and the great number which will have to be stored in the future, many of them stored out on airport property due to lack of adequate hangar facilities, definitely affect the problem under discussion.

Under the Civil Aeronautics Act of 1938 it becomes the duty of the Administrator to promote safety in Air Commerce and to prescribe minimum standards governing appliances required and serving the interest of safety in Civil Aeronautics. Therefore, aviation fire protection problems become our interest by law.

We, in the Technical Development Division of the C.A.A., are vitally interested in fire protection problems. However, it has only been recently that funds have been made available to us for studies and research work dealing with fire defense problems pertaining to aviation.

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This article is condensed from a paper presented at the 45th Annual Meeting of the National Fire Protection Association, Toronto, May 12-16, 1941. The author is Chief of the Airport Development Section, Technical Development Division, Civil Aeronautics Administration.

The U. S. Army Air Corps took the lead as early as 1923 and 1924, through the initiation and actual testing of aircraft fire causes resulting from crashes. Obsolete airplanes with engines running were hurtled down steeply inclined tracks against brick walls or were otherwise caused to crash. The findings resulted in numerous improvements in aircraft design, such as carburetors, exhaust manifolds and fire wall designs.

The Bureau of Aeronautics of the Department of Commerce, now the C.A.A., initiated its first studies of automatic sprinkler protection for airplane hangars in the Spring of 1930. A fact finding committee was organized to investigate this subject by means of tests under actual operating conditions. A wooden hangar donated by the National Committee on Wood Utilization of the Department of Commerce and a number of obsolete aircraft were used during these tests which were conducted at the Bureau of Standards in Washington, D. C., and which no doubt are familiar to you. Although the necessity for additional studies along this line became quite apparent, further progress on this problem has been impossible since then, due to lack of funds. (Proceedings, 1930, page 125.)

Our next study dealt with the elimination of fire hazards due to fuel dumping from aircraft. About two years ago, when provisional gross load regulations became effective, tests of actual fuel dumping operations from aircraft were initiated by the Technical Development Division. Under this aircraft design regulation provision it became possible for aircraft to take off with large quantities of fuel to increase their range of operations. However, to assure operating safety in the event that one engine became inoperative or during forced and normal landings during such load conditions, facilities for the safe dumping of fuel from aircraft had to be provided. One of the outstanding hazards of such operations was the effect of static electricity, which is believed to be the direct cause of the so-called explosion of aircraft in the air. These tests were conducted at the Bureau of Standards in Washington with the aid of wind tunnel equipment in simulating actual flight conditions. As a result of this research work and the design of improved dump valves and ejection nozzles, plus a regulation covering their use, it became possible to achieve practically complete immunity from fire hazards due to fuel dumping.

Our next study dealt with aircraft engine fires in flight. For the past eighteen months the Technical Development Division has been conducting an aircraft power plant fire test program at the National Bureau of Standards. The objectives of this program are to develop the most effective method of eliminating and controlling aircraft engine fires in flight.

The test equipment consisted of a full scale stub wing and nacelle in which was mounted a standard radial engine complete with conventional cowl and propeller. The tests were conducted out of doors, the equipment being erected in front of a wind tunnel so that simulated flight conditions could be obtained.

With the engine running, gasoline and oil were burned in the engine nacelle and accessory section to reproduce the type of power plant fire which might be encountered in actual flight. Fire suppressing and extinguishing materials were then released to test the effectiveness of these materials on fires following engine structural failure or failure of the fuel or oil systems.

As a result of this test program, design criteria and methods of proper application of fire detectors were determined. Exhaustive tests on various types of fire extinguishing agents resulted in valuable data concerning the relative efficiencies and required amounts of the agents, and in information regarding the proper design of distribution systems.

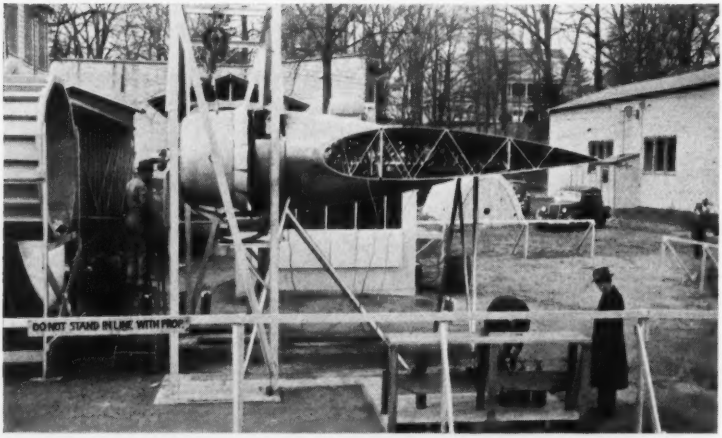
Extensive temperature measurements throughout the nacelle and on the wing surface in its vicinity have provided reliable data concerning the effect of fires in flight on the materials comprising the power plant installations and the nacelle and wing structure.

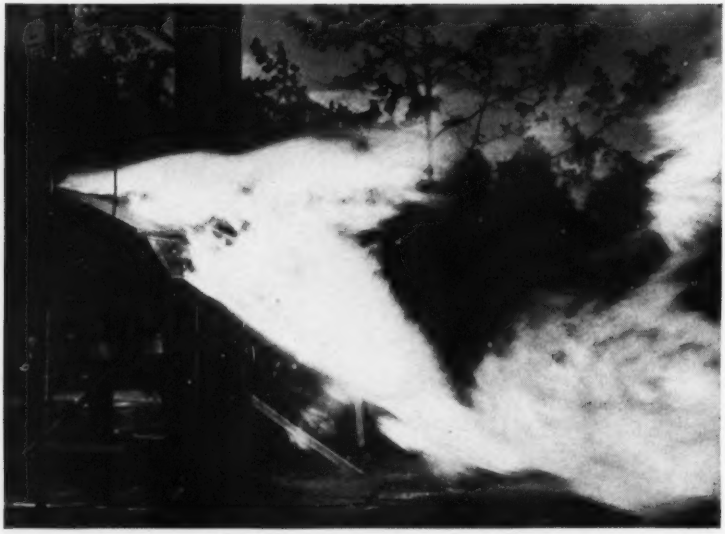
A report of the phase of the test program which has been completed to date is now being written and will be published in the near future. A continuation of the fire test program is under way at the National Bureau of Standards, and will involve similar tests on other cowling arrangements, tests with other conventional engine installations, and the consideration of fire hazards apart from those connected directly with power plants.

Coming to airports we, in the Civil Aeronautics Administration, again have a right, and the duty to concern ourselves about fire defense problems for the protection of airport facilities created through the expenditures of millions of dollars subject to certification by the Administrator of the C.A.A.

Let us return now to the first item mentioned, namely, airport size and location, and how it affects fire protection. The trend in airport planning, so far as location is concerned, both from the commercial and especially from the military standpoint, usually is towards sites at considerable distances from the protection facilities provided by metropolitan centers.

This calls for special consideration of the sources of water and power supply, and of the mobility and range of combination fire-crash truck equipment. In localities where such protection is dependent upon county and municipal mobile equipment, considerable time intervals are required for such auxiliary equipment to reach the airport or the crash scene. As an example of the increase in radius of airport approach zones, and its relation to mobile equipment, some years ago we advocated 7 to 1, then 20 to 1, approach ratios, where today the recommended standards for radio approach zones are 45 to 1, with a possible future 50 to 1 ratio. This change in ratio has been brought about by the increase in aircraft speed and the installation of improved air navigation facilities, which makes possible approaches in low ceiling and poor visibility conditions. Needless to say, this calls for clear approaches to avoid obstruction hazards, particularly approaches clear of power lines. This is still a long



Tests to determine safe methods of gasoline dumping were conducted at the National Bureau of Standards. The upper picture shows the test set-up with the discharge from a wind tunnel directed at a wing section. The lower picture, typical of a large number of tests, shows fire due to discharge of 40 gal. of gasoline per minute. It was found that when the dumped gasoline came in contact with the wing surface, ignition might occur due to static electricity. Eventually, as a result of these tests, a safe design was developed.

way from being an actuality, and power lines in airport approach zones still present a problem amounting to more than a fire hazard in case of airplane crashes. To again emphasize the importance of mobile equipment used at airports for rescue and fire fighting purposes, I am quoting from a recent study covering fatal or serious aircraft accidents which occurred on or in close proximity to airports. Because of the number of accidents which have been reported in 1940, the study was confined to fatal and serious ones, which in almost all cases required fire fighting and rescue facilities. "Due to lack of complete information, it was found extremely difficult in some cases to locate accidents with reference to the airport.

"To date, a combined total of 450 fatal and serious aircraft accidents have been processed and this number represents some 13% of the approximate 3500 major accident reports received for 1940. These 450 accidents have been segregated as follows:

Fatal and Serious Accidents — 1940.

| | | |
|---|---|---|
| Number occurring on airport | 119 | 27% |
| Number occurring within 5-mile radius of airport | 190 | 42% |
| Number occurring outside 5-mile radius of airport | 141 | 31% |

"It will be noted that 69% of the 450 accidents occurred either on the airport or within a five-mile radius therefrom, the remaining 31% having occurred beyond a five-mile radius of the airport." This study indicates the demands which will be made on mobile equipment.

### Crash Trucks.

A recent study of existing mobile equipment designed for aircraft crash rescue and fire fighting purposes shows that there is a definite trend toward heavier equipment, particularly at larger airports, which is easy to understand in view of the requirements for larger fire fighting capacities. If limitations of size and weight become evident for individual localities, it may be necessary to develop multiple units.

The large percentage of crashes and aircraft fires having occurred within a five-mile radius of airports and probably in severe terrain certainly warrants further studies of power and maneuverability characteristics in chassis design.

Facilities for saving of human life can most certainly be improved upon — the development of hand and power tools, such as circular saws, designed for providing exits out of or ingress into crashed fuselages, should be given immediate consideration and provisions for the application of water spray during such cutting operations to avoid fires caused by sparks should be incorporated. Water sprays would also be valuable for the protection of rescue parties.

Provision should be made for adequate power and mechanical devices such as hoists, booms, winches, tow cables, fog nozzles, grappling hooks, etc. Also small engine generator equipment with push button start for floodlighting crash areas and for operation of power tools. (During a recent airline crash, it

required 2½ hours to extricate the pilot and co-pilot from the wreck due to inadequate rescue facilities.)

Two-way radio facilities on the truck are quite essential; also loud speakers should be very helpful.

### Crash Boats.

Crash and rescue boats come into a category of their own and should be designed for each specific locality and specific operation.

In this connection I should like to mention a beautiful 58-foot crash boat I saw last fall, powered with 1500 horsepower and capable of speeds up to 45 knots — equipped with every accessory imaginable. There was only one thing wrong with it — the boat couldn't get to the crash scenes in 60% of the cases because it was drawing 6½ feet of water, and the water depth of most of the area in this particular bay was only 1½ feet at average low tide.

### Hangars.

The past record of hangar fire protection is certainly not impressive. The fire losses over a ten-year period, from 1928 to 1938, taken from the records of the National Fire Protection Association, are astounding, running into millions, and still more astounding are the number of hangars *not* equipped with any type of fire protection devices whatever. The April 1941 N.F.P.A. QUARTERLY records the fact that in the period 1931 through 1940, no large building loss occurred in sprinklered hangars and that only one plane was destroyed. The totals of the former statistics show the following:

Number of Fires — 124. In only 6 of these fires were the hangars equipped with sprinklers.

Planes destroyed — 385.

Needless to say, 385 airplanes would make a lot of difference at this present time. Worst of all, the replacement of the equipment would be the most serious problem, not to speak of the loss of housing facilities. In these days when aircraft, particularly military equipment, is so urgently needed, it is tragic that such lack of foresight exists. Considering the present day fire hazards in airplane hangars, it should be recognized that there is a difference between the problem we are facing today and that of ten years ago. At that time the average hangar ceiling height was 25 and 30 feet, whereas today we have hangar ceiling heights of 60, 70 feet, and more. Hangar floor space and width of door openings have changed, as well as ventilating systems of various types. Ten years ago the materials used in the fabrication of airplanes were mostly wood and fabric with the exception of fuselage. Today, practically all the larger type, particularly military equipment, and a few of the smaller type commercial aircraft are of aluminum alloy construction; however, fabric covering is still being used for ailerons, rudders, and elevators on quite a number of these planes.

A few years ago, the only slip necessary on the part of a careless mechanic was to touch the fuselage or the wing covering of a fabric covered airplane with

a hot drop light bulb and within a few seconds the airplane and probably four or five others next to it were a mass of flames. After the fixed temperature automatic sprinklers operated and the fire was out we probably saved the hangar, but we still had to face damages varying from to 20 to 75% of the total valuation of the air craft involved.

Today we have a little different problem — flash points of wet fabric aircraft finishes are probably still ranging from 85 to 105° F., but some progress has been made in producing aircraft finishes which have a high ignition temperature when dry. Therefore, we have gained something because the hazard time period involved is improved in our favor. However, we should remember that the volume of the hazard has increased considerably. We now have large transport planes, in some cases valued as high as one-half million dollars each, with large cabin and fuselage facilities, housing electrical wiring, radios and other combustible material. Inside the wings of such airplanes are hundreds of gallons of gasoline — as much as 4200 gallons in the Boeing Clipper ships. Should a fire start in one of these fuselages, and spread to the wing structure, then we may find ourselves with 4200 gallons of flaming gasoline splattered in all directions. Probably two other clippers may be housed in the same hangar, or possibly 8 Douglas B-17's with a total capacity of 16,000 gallons of highly flammable fuel.

### Sprinkler Protection.

This example is to emphasize the increase in property value, in both airplanes and hangars, which requires protection, and also the need for protective measures adequate to cope with this new condition confronting us — keeping also in mind that aircraft built out of aluminum alloy, which contains a considerable percentage of magnesium, will burn at high temperatures, and within a very short period of exposure. The design of sprinkler systems for manufacturing or warehouse buildings of ordinary hazard and ordinary ceiling heights has little relation to the design of sprinkler systems for airplane hangars. From the available records it is evident that the design of sprinkler systems for airplane hangars is a major engineering problem, involving: (1) proper spacing of sprinklers to insure adequate coverage of floor area as well as ceiling, and proper spacing of thermostats to operate the individual sprinkler systems; (2) proper design of the individual sprinkler system; (3) calculations of friction and static losses to determine proper pipe sizes for reasonably uniform discharge from the sprinklers; (4) design of an adequate water supply.

### Education of Personnel.

Next we come to something which appears elementary, which, however, has proven a difficult problem in the aviation field, namely, the education of personnel so that they may be competent in the handling of aviation fires. At almost all of the airports in the U. S. A., we are depending on regular airplane service personnel and airport attendants to act as fire fighters, since it would

**Set-up for aircraft power plant fire tests.**

be economically impossible at the present time to retain full-time specialists for the sole purpose of fire protection. Everyone recognizes the necessity of competent and experienced personnel for coping with aviation fires, which probably come in a category of their own, as far as types of fires are concerned. Quite a number of aircraft and hangar losses could have been avoided if airport personnel had been properly trained, even though in some cases we hear about specially trained personnel making a blunder. May I cite one outstanding example which happened in 1938. A smoldering fire started late at night in an airplane stored in a fairly large hangar. There were about 20 airplanes housed in this hangar — one of them valued at $350,000. A Department of Commerce Weather Bureau employee noticed smoke coming from under the door of the hangar and woke up the night watchman to tell him about it. Not being very familiar with such things as airplane fires and not being at all sure what to do about it, he decided to send up a trial balloon. Poor Fido, the watchman's dog, was elected to be the guinea pig. The watchman put Fido into the hangar through the office door to observe his reactions to the rather obnoxious smoke. Fido came back yelping, which proved to the watchman that the airplane fire was no place for him if the dog couldn't stand it. Therefore, he called the fire department of his booming little suburban community. While he was waiting for them to arrive, the wachman decided to unlock the hangar door to roll some of the airplanes out in the open. It was found that this couldn't be done because the airport manager had the door key in his pocket and he was home peacefully asleep. Finally, the suburban fire department arrived, broke

one of the hangar doors open and proceeded to attack the still-confined fire with a garden hose. The fireman who came running into the hangar with the garden hose evidently had sufficient pressure on his line to put the fire out in very quick order. However, when he arrived within 10 feet of the airplane the water quit running. It was found, upon examination, that the well was dry! The Chief of the suburban fire department phoned the chief of the neighboring metropolitan fire department and asked for help. The big city neighbor told him that the metropolitan fire department had no legal jurisdiction to come to their rescue and that, of course, they were very sorry about it. However, to show them that their heart was in the right spot they would see what could be done about it if they could reach the city attorney, who was out on a party somewhere in town. Evidently this was accomplished, because almost the entire metropolitan fire department was sent on its way before the suburban fire chief, who by this time was at the stage of tearing his hair, was informed of the good news. Upon arrival at the airport, the metropolitan fire department proceeded to break all windows and open the hangar doors wide, with the result that within a few seconds the entire hangar developed into a flaming inferno, with a total loss of the hangar and all airplanes. This is not fiction, but happens to be a true story, and even in this extreme case, a small amount of education on the handling of hangar and airplane fires might have saved a considerable number of airplanes and a practically new hangar. Fortunately, some progress has been made recently in the training and education of aircraft service personnel in the handling of aviation fires, as several airlines have started routine fire drills for their shop and hangar personnel. However, there is considerable room for improvement due to the complex nature of the various types of aviation fires we shall have to meet — such as dope room, paint and dope storage, aircraft parts, including aluminum-magnesium alloys, gas and oil storage, boiler rooms, electrical equipment including radio — all these possible fires cannot be handled by one type of protection equipment and not by one method nor by inexperienced personnel. The airport personnel usually lacks knowledge as to the proper treatment of various fires under variable conditions and with the most effective medium available.

The frequent loss of experienced personnel to military organizations and to aircraft manufacturing plants requires repeated training for new employees. The most recent progress along this line has been the introduction of a course for the training of airport service personnel. This work is being done under a W.P.A. project with the coöperation of the C.A.A. and the Office of Education. The eventual goal is to train 5000 of these service men. Among the subjects in this course is that of Airport Fire Protection.

Due to the varying circumstances which may be expected in connection with aviation fires and the many various applications of fire fighting equipment which may have to be called into service, it is desirable that all such

equipment be designed as simply and with as few gadgets as possible. It should be so simple and reliable as to permit the operator to make occasional errors without subjecting himself to extreme hazards and serious injuries.

## Conclusions.

The report of a Fact Finding Committee on the Control of Airplane Hangar Fires by the Automatic Application of Water, dated September 1, 1930, made certain fundamental observations as a result of tests conducted at the Bureau of Standards in Washington. All of these findings and recommendations are basically sound and in principle applicable to the problem we are facing today in hangar protection. The definite limitation of application of water by fixed temperature automatic sprinklers under conditions of high ceiling heights, and where ventilation causes horizontal drafts, has been fully recognized as well as the advantages of open sprinkler systems operated on the rate of temperature rise principle.

In general, it can be said that the fire hazard in hangar protection can be considered as falling into two categories. The first is a small fire, which may be of great intensity, but which is confined within the body of an airplane, and must be fought with portable equipment; and the second is a general fire outside the body of the airplanes, and which must be met with the proper kind of sprinklers, deluge equipment, and other built-in protection. This is quite different from the problem a few years ago, when quick flash fires constituted the major hazard. Our observations can be briefed as follows:

1. The development of aviation fire protection equipment should progress proportionally, preferably ahead of the requirements to be faced through the rapid advancement in aviation.
2. In all phases of fire problems where personnel may be involved either as fire fighters or in rescue work, the protection of such personnel is paramount and proper equipment for such operations should be given immediate consideration.
3. Mobile equipment on airports must be designed to meet the ever-increasing requirements for maneuverability and higher capacity to perform rescue work and to effectively combat fires within airport zones.
4. Mobile and portable equipment within hangars should be improved adequately to handle fires of considerable intensity within the fuselages of 21- and 50-passenger airplanes, again giving protection of personnel due consideration.
5. Deluge systems of open sprinklers actuated by rate of temperature rise should be installed in hangars with high ceilings in order to assure effective protection of hangar and aircraft.
6. Better coördination of airport fire protection and local fire departments is imperative.
7. Educational efforts for the training of airport personnel concerned in fire protection problems should be undertaken immediately.
8. Development and use of special mobile equipment should be encouraged, such as proper facilities for handling high tension wires and for running gasoline fires, etc.

# Age of Municipal Fire Apparatus.

By Warren Y. Kimball,
N.F.P.A. Engineer.

Of 3887 pumpers and ladder trucks in service in 365 United States cities of 20,000 and over population, 2016, or 51.9 per cent, are over 15 years old, according to a survey made recently by the Executive Office of the National Fire Protection Association. While such apparatus might be valuable as a reserve, it cannot be expected to meet the severe requirements of active fire defense and heavy prolonged usage.

Apparatus which is more than 15 years old is outmoded, first as a truck and secondly, as fire fighting equipment. As a truck, a piece of apparatus which is 15 or more years old may be compared in some respects with an automobile of the same age. Few automobiles or trucks of such age remain on the roads today. Fire apparatus which is more than 15 years old may have two-wheel brakes, solid rubber tires, and many other features which make the apparatus entirely inferior and undependable. The good or bad condition of its paint and nickel plating is little measure of its worth.

From the standpoint of fire fighting, apparatus which is more than 15 years old may lack many of the improvements developed within that period. Its original appliances may have become worn and undependable.

On May 2 the N.F.P.A. Executive Office sent a questionnaire to the fire chiefs of the 510 cities of 20,000 or more population in the United States, requesting information as to the age and number of fire department pumpers and ladder trucks in service in their communities. Returns had been received at the end of May from 365 cities, or 72 per cent of the total. Although returns continue to come in, this number gives an accurate picture of the situation.

A total of 3887 pumpers and ladder trucks are in service in the 365 cities reporting.

1012, or 26.0%, are 16 to 20 years old
1004, or 25.9%, are over 20 years old

2016, or 51.9%, are over 15 years old.

### Pumpers.

Of 2869 *pumpers* in active service in 365 cities:

760, or 26.5%, are 16 to 20 years old
736, or 25.6%, are over 20 years old

1496, or 52.1%, are over 15 years old.

Of 365 cities reporting, 38, or 10.4%, have no pumpers in service that are under 16 years old. Other cities numbering 169, or 46.4%, have less than 50% of their pumpers under 16 years old. In other words, 207, or 56.9%, of the cities report that less than half of their apparatus is under 16 years old.

### Ladder Trucks.

Three hundred and fifty-five cities reported 1018 *ladder trucks* in service. (Ten cities have no separate ladder trucks in service.)

252, or 24.7%, are 16 to 20 years old
268, or 26.3%, are over 20 years old

520, or 51.0%, are over 15 years old.

Of 355 cities having ladder trucks, 100, or 28.2%, have no ladder trucks in service that are under 16 years old. Other cities numbering 96, or 27.0%, have less than 50% of their ladder trucks under 16 years old. In other words, 196, or 55.2%, of the cities having ladder trucks report that less than half of this apparatus is under 16 years old. Of the 130 cities having only one ladder truck in service 57 reported the truck over 15 years old.

While the information was not specifically requested, 15 chiefs reported a total of 17 pumpers and 11 ladder trucks on order or appropriated for. Of the 3887 pieces of apparatus reported in service, a total of 15 pieces are specifically indicated as combined pumper-ladder trucks. These have been included in the tabulation in whichever class of service they were listed by the chief making the report.

It is further reported that six old pumpers have had new motors or have been rebuilt. Three old ladder trucks are reported to have had new motive power.

Obviously, much new fire apparatus is going to be needed by the majority of American fire departments if an adequate fire defense is to be maintained. Many cities are now willing to make the necessary apparatus purchases. Others are beginning to see the need for new apparatus. But now, another obstacle stands in the way — priority restrictions. The materials which are sorely needed for the construction of new fire apparatus cannot be obtained unless officials at Washington appreciate the importance of adequate fire apparatus for home defense and grant priorities to fire apparatus manufacturers for materials essential to the manufacture of fire apparatus.

As a result of this situation, the N.F.P.A. at its 45th Annual Meeting in Toronto, May 12 through 16, passed a resolution in which the governmental authorities were asked to grant fire apparatus manufacturers defense priority. This request was made on the basis that adequate, modern fire fighting equipment is absolutely necessary for fire defense in the national emergency.

# Forest Fire and National Defense.

By David P. Godwin,
Chairman, N.F.P.A. Forest Committee.

During the period April 14 to April 23, abnormally hazardous fire conditions were prevalent throughout the New England and Mid-Atlantic States, resulting from a long drought, high temperatures, and heavy winds. During this period about 5400 wood and brush fires were reported which burned over approximately 280,000 acres and caused damage of probably $3,000,000, a considerable part of which was due to the loss of dwellings, barns, farm and other improvements, poultry and livestock. It is reported that about 50,000 fire fighters were called out, and it was estimated that approximately 1,000,000 man days' time was spent in fire fighting.

State protection agencies reported that they had considerable difficulty in securing sufficient men to fight the fires. We have no way of knowing to what extent the use of these men in fire suppression affected work which would otherwise be devoted to national defense. We do know, however, that a large number of soldiers from Camp Dix were used on fire suppression and undoubtedly part of the other fire fighters were taken from work either directly or indirectly related to national defense.

These devastating fires were not within national forests, but now in the East, and later in the summer in the West, the Forest Service can expect the same threat on the areas under its jurisdiction. Roughly one-third of the United States is forested, and under favorable circumstances at certain seasons these areas reach a high peak of flammability.

Lightning is still with us and human carelessness is still with us, and from those sources we can expect at least the average number of fire occurrences. These, as in the past, we believe our field organization can cope with. But because of possible unrest and dissatisfaction within and hostile threat from without, we foresee greater dangers ahead. Within our population are malcontents, opponents of our government, agitators, subversive agents who for one motive or another will employ fire in the woods as an instrument of sabotage. With no intent at alarm, I can state our belief that to some degree such incendiarism will express itself even without America's entrance into the war and even without America becoming a theatre of war.

Should the United States suffer attack or invasion by a hostile force on its coasts or from its borders, Army authorities advise us that we can assume that enemy plans will involve the full use of forest incendiarism. I quote from a recent letter from one of the highest ranking Generals: "I am in full agree-

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This article was presented as an address at the 45th Annual Meeting of the National Fire Protection Association, Toronto, May 16, 1941. The author is Assistant Chief, Division of Fire Control, Forest Service, U. S. Department of Agriculture.

*Acme.*

**Forest fires interfered with National Defense from April 14 to April 23, when it is estimated that 1,000,000 man days of work were spent fighting forest fires. Above, men from Camp Dix in New Jersey working desperately to stem the oncoming flames. Sailors also aided.**

ment that the prevention and control of forest fires is of outstanding importance from a military viewpoint, and that in view of the increasing possibility of acts of incendiary sabotage, provision should be made to strengthen the Forest Service to handle any abnormal fire situation which may occur. Plans for preventing and fighting forest fires should provide for making the maximum use of civil agencies since it is not likely that troops would be available for fire fighting except on military reservations."

Past experience demonstrates that incendiary fires can be successfully set by determined men operating on the ground. This in itself is bad enough, but it cannot be compared with the havoc which could be wrought by incendiarism from the air. In dry and windy times a small fleet of airplanes loaded with small incendiary bombs or chemical substances could start hundreds of thousands of fast running fires in a single night in one or a dozen states. Aside from the outright destruction of timber and other essential resources, such incendiarism would result in disruption of transportation and communication facilities and structures, diversion of man power, both military and industrial, from essential defense activities, would create great smoke palls to mask offensive operations and would tend to bring about general fear and public confusion. The Forest Service with its present organization is prepared to cope with any ordinary degree of incendiarism in or near national forests. At times it has had

*U. S. Forest Service Photo.*

**One of the 3200 lookout stations scattered far and wide throughout our nation's forests by the Forest Service. These lookout stations may become invaluable in the event of invasion by reporting the approach and direction of enemy planes by radio. In trials already made, they proved themselves to be effective in doing this sort of spotting work.**

to deal with 100 to 200 fires set on a single national forest in one day by lightning. But we must build up and extend our forces and use ever greater effort to cope with a situation where fires could be started quickly and in large numbers, realizing that even the utmost speed in recruiting and organizing fire fighting crews from the usual labor supplies might be too slow to avoid disaster.

For two years we have participated with the Army Air Corps in maneuvers to demonstrate the effectiveness of the Aircraft Warning Service. The Forest Service operates 3200 lookout stations throughout the national forests of the country and in these various units these observation points are tied into our communication network which at present consists of 63,000 miles of telephone line and about 3000 radio stations. The Forest Service also has coöperative working relations with a great number of state detection and communication systems and those of the National Park Service.

In the maneuvers of 1939 and 1940, squadrons of so-called enemy airplanes took off from undisclosed distant points and approached centers of military and industrial importance on the Pacific Coast. Our lookouts knew only the day chosen for the flight, not the hour or the direction of approach. Each lookout man, trained for detection of distant objects or movement, and equipped with binoculars and the standard fire locating instrument, picked up the distant specks in the sky and by telephone or radio reported through designated communication lines the location by azimuth and the course of

*U. S. Forest Service Photo.*

**A parachutist of the Forest Service tangles in some pines on landing. Special equipment has been developed during the last two years which aids the 'chutist in getting out of predicaments such as the one shown above.**

flight. These messages, correlated by dispatchers, were channeled down to the Army G.H.Q. At that center it was possible to follow on a map the whole course of the flight by time and distance.

The Air Defense Command of the Army recognizes that this great network can be of great value in times of emergency. Full information as to installations and locations has been furnished to the Army and is being integrated with their master plan for reporting the approach and movement of hostile aircraft in all sections. Naturally, the Forest Service mans and maintains these lookout stations and most of the telephone lines only during the periods of forest fire danger. Should the emergency develop it will be necessary in collaboration with the Army to provide for year-long operation and to extend and connect up many hundreds of miles of communication lines.

In previous years Mr. Roy Headley, my predecessor as chairman of the Forest Committee, in presenting his paper at the annual N.F.P.A. meeting has reviewed the forest fire control developments in new equipment and techniques. This year we have evolved some new equipment and carried others to fuller development. We have in some respects greatly improved our methods of attack and line construction and other systems in the field of management. However, rather than make a review of these various activities, I shall concentrate on the recent development of the technique of delivering fire fighters in remote regions by parachute.

Study of the time records of forest fires always brings re-emphasis of the inescapable truth that travel time is a paramount factor in determining the size of burned area. "If only one man had been there early." Since the beginnings of systematic forest fire control men have therefore bent their thought and energies toward the extension of forest ways and to faster means of travel over them. In the national forests we maintain a vast network of transportation routes — thousands of miles of roads and trails. Along these routes, by foot, by horse, and by motor go the men dispatched to suppress fires.

Gradually the extension of roads and the addition of vehicles are slowing down as the point of diminishing returns approaches. What then? Will current travel time achievements become static? On the other hand air transportation, if we can intelligently adopt it to our ends, may open up an era of time-cutting which our present fire plans have hardly glimpsed. For some years we have used planes to transport fire fighters to small landing fields in the back country, but in rough terrain opportunities for landing fields are extremely scarce, and once having landed men by plane they still have long hikes ahead of them. This, therefore, is no final solution. We eventually faced the question, "What can be done to land men without landing the planes?" The question, of course, is not new. For years fire control men have mused and argued about the possibilities of parachute jumping of trained fire fighters near small fires in back country and thus catch 'em early. In the late summer of 1939 it

*U. S. Forest Service Photo.*

**A forest fire fighter waits for the signal from the pilot of the plane before leaping. He uses his left hand to hang on to the plane and with his right hand, he clutches the ripcord of his chute. These fire fighters are provided with all kinds of special equipment to aid them in their work.**

was decided to thoroughly explore the whole subject. A small crew was organized at a spot in the foothills of the Cascades in Northern Washington. From this point north to the Canadian border stretches a great area of remote territory where present travel time maps show zones running up into many hours. Its variety of terrain offered ideal proving grounds.

At first dummies weighing 180 pounds attached to condemned Army parachutes were dropped at various elevations over various types of cover and topography. Close observation was maintained from the air and on the ground. Then began the jumping of men. The first were professional parachute jumpers. But soon they were followed by our local men with smoke chaser experience, most of whom had never seen a parachute before. All jumps

*U. S. Forest Service Photo.*

**Interior of one of the lookout stations maintained by the Forest Service. The disk-shaped instrument is a "fire finder" which is used to locate a blaze in the surrounding forests. The position of the fire is then phoned to a central station, from whence forest fire fighters are dispatched. About 3000 out of a total of 3200 lookout stations are equipped with radio receiving and transmitting sets.**

were successful. During the 6 weeks before the setting in of storms in the high country 60 live jumps were made and in no instance was a man injured in landing. They dropped into mountain meadows and onto slopes and ridges, landed in fir trees as high as 135 feet and even in tall snags, and these landings varied in altitude from 1700 to 7000 feet.

Existing equipment was not suited to such work and much preparation was necessary. Protective clothing of padded tough material and special helmets and masks were designed and made. Parachute harness was revised and made more quickly detachable. The parachutes selected were of the most advanced type, 30 feet in diameter and constructed with a wide scalloped periphery devised to provide slow rate of descent and minimum oscillation, and two long flaps to provide a degree of steering. A special rope arrangement was provided for lowering from tree to ground. Smoke chaser's pack with usual tools and supplies was made ready for dropping by small burlap cargo chute to the jumper after landing.

Every jump was different, but gradually the methods smoothed out into standard practice: The plane, with door removed, leaves the landing field, carrying one or more jumpers wearing jumping suits and harnessed with parachutes. After making altitude and sighting the smoke the course is set and approach is made into the wind at 2000 feet above the target. At what appears

*U. S. Forest Service Photo.*

**Radio apparatus is now being used at the scene of the fire. Above, an engineer of the Forest Service reports the progress fire fighters are making to his central station. Parachutists are equipped with radio transmitters which weigh only 5½ pounds and which fit into the pocket of their jumping suits. 'Chutists have landed and set up communications with their plane only 8 minutes after jumping.**

to be the right position and moment a weighted burlap test chute is dropped, and as the plane is banked, its descent and landing are observed by the pilot, who circles and makes the next approach, having noted wind drift and made correction. The jumper has moved into sitting position in the doorway and upon signal from the pilot bails out, and after waiting the proper interval to clear the ship pulls the ring which releases the 'chute. His descent takes 2 or 3 minutes, which gives him time to maneuver his lines. He lands in a tree, the canopy holding above him and bringing him to a slow stop. He passes his rope through a ring in the riser straps attached to the shroud lines and lowers himself to the ground, where he divests himself of harness and suit. On the final approach the pilot drops the smoke-chaser's pack, containing food and tools.

The engineers in our radio laboratory designed an extremely compact and efficient two-way radio set. This weighs 5½ pounds and is about the size of a small loaf of bread. This is fitted into a pocket of the jumper's clothing and enables him to set up communication after landing. In one instance, which I clocked, the jumper on the ground had set up his radio and was in communication with the plane 8 minutes after he had left the open door of the plane.

During the winter of 1939-1940 the whole project was overhauled, and following the decision to extend the work to Montana in addition to the Cas-

*International.*

**A raging forest fire sweeps past the woods and into town. This fire which occurred in and about Lakewood, N. J., on April 20, was only one of 5400 forest and brush fires reported in the United States during the third week in April. The fires burned an estimated 280,000 acres and caused damage approximating $3,000,000. Fifty thousand fire fighters were called out.**

cade country additional equipment was designed and procured and detailed plans were made for training of new personnel and expansion of the scope of the work. In June, 1940, the work opened up in both regions and was continued throughout the season of last summer. Now it can be definitely said that the method with all its accessory techniques and equipment is mechanically or technically feasible. Stating it differently, it has been proven that the members of our own fire fighting personnel (and there is no lack of volunteers) can fly out over practically any type of forest, jump and land successfully and extinguish fires. That of course does not complete the story. It must be demonstrated that smoke jumping is a practical adjunct to our present ground methods, and that it can be made to pay. We now believe that net financial savings are evident. Last summer on the Bitterroot National Forest in Montana two fires were controlled on August 20 by four parachutists at a total cost of $320. Eight other fires on the same day under comparable conditions in Bitterroot back country were manned by walking crews from road ends. These fires burned from 100 to 1900 acres each, with control costs varying from $2000 to $17,000 each. The estimated saving in these two cases is $20,000.

Another of several examples is a report received from the Supervisor of a national forest in the Cascades. I quote: "A fire was discovered from the plane yesterday, September 10, in blind territory of Little Bridge Creek, 12

miles from the nearest road. Two parachutists jumped on this one, landing about 600 feet below the fire on an open hillside. The fire was blazing up at the time. They promptly displayed the OK (yellow streamer) and went to the fire immediately. Two hours later only a lazy smoke was visible to the observer in the plane.

"There were no smoke jumpers last year when a lightning fire started in this same country. We dispatched fifty of our best men immediately, some going by saddle horse. It was a 12-mile hike and a rise in elevation of about 5000 feet. Follow-up was necessary and the fire burned 800 acres. We had two camps of about 200 men each, several strings of pack horses and the total cost was over $10,000." The estimated saving in this case was $7000.

Aside from any real reduction this season in damage and costs an incidental and somewhat intangible value has been produced. The spectacular nature of the work has magnetized more public attention through press, movies, and radio than any one forest activity in several years. This, it may be reckoned, will result in greater public interest in forest protection.

As is generally known, mass jumping by parachute was originated by the Russians in 1936. This was picked up by the Germans and during the last few years developed to the high state of efficiency which is known to us all. However, our own Army was slow to discover the need and effectiveness of this new arm. In starting our forest work therefore, we were unable to secure from the Air Corps much helpful advice and no equipment. Last June when preparing for our summer's operations in Montana, General Arnold, Chief of the Air Corps, was advised of our plans and immediately made arrangements for observation of our work. That this was of material assistance to the development of the Parachute Battalions of the American Army is testified to by the following quotation from the Infantry Journal of January, 1941, written by Colonel Wm. C. Lee, now in command of all parachute troops. "Our new aerial development has naturally called for considerable study in order to find out what kind of equipment will serve best, especially for the parachute troops. In the course of this study it was found that the Forest Service, a branch of the Department of Agriculture, was using, out in the mountains of Montana, especially developed equipment for dropping groups of as many as six or eight men in isolated roadless forest areas to fight forest fires. Five officers representing the Office of the Chief of Infantry, the Air Corps, and the Infantry Board went to Montana for a week to study the equipment and methods of the Forest Service. Every facility was extended to the visiting Army officers. This visit and the enthusiastic coöperation of the Forest Service enabled us to gain the full benefit of their experience and saved many weeks of experiment in the development of parachute troops."

# Dust Explosion Hazards of Powdered Metals.

By Hylton R. Brown,

Secretary, N.F.P.A. Committee on Dust Explosion Hazards.

Many persons who readily recognize the possibility of a dust explosion in a plant handling carbonaceous dust are inclined to accept with mental reservations the statement that metallic dusts also may be explosive. It is difficult for them to understand how metals, such as iron, zinc, aluminum, tin, etc., commonly considered non-combustible, can burn with great rapidity and explosive violence when in a finely divided state.

Dust explosions have occurred frequently in connection with the production and handling of carbonaceous dusts, and safety codes or standards containing recommendations for protection against such explosions have been prepared for a number of industries where the hazard exists.* It is only recently that metal powders other than aluminum and zinc have been produced in relatively large quantities. This increased production has been brought about by the rapid growth of powder metallurgy—the fabrication of metal machine parts and other objects from finely divided metal powders or mixtures of such powders.

It has been found possible to produce large quantities of small metal objects rapidly and economically by the powder metallurgy process. Molds or dies are prepared and in these the powdered metal is pressed to form a solid object of the desired shape and dimensions, with characteristics similar to or more desirable than the cast or machined parts they are designed to replace. With automatic presses, small bearings, gears and other machine parts can be produced in a fraction of the time required by other methods, and costly operations such as machining and finishing can be eliminated. It is also possible to affect the weight, strength, toughness, hardness and other qualities of the product by combining or "alloying" two or more powders in different proportions.

More than 30 different types of metal powders are now on the market, many of which are handled in such large quantities that their production is referred to in thousands of tons. Although the layman may be skeptical about

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This article is published by permission of the Director, Bureau of Mines, U. S. Department of the Interior. The author is Senior Engineer, Safety Division, Bureau of Mines, Pittsburgh, Pa.

*"National Fire Codes for the Prevention of Dust Explosions," obtainable from National Fire Protection Association, contains codes adopted by the N.F.P.A. and approved by the American Standards Association.

the explosive properties of metal dusts, experienced producers and users have recognized the hazard and many have endeavored to provide the necessary protection. These efforts to provide safe operating conditions and the necessity of guarding against dust ignitions should be brought to the attention of new operators and employees as additional plants are opened and as other uses for metal powders are developed.

Established operators have submitted some dust samples to testing laboratories to determine ignition temperatures, explosive limits of concentration, and the different factors affecting explosibility. However, many of the new powdered metals and alloys have not been tested to determine their relative flammability, and for some of the other metal dusts data based upon preliminary tests only are available. It may be interesting to note that some of the metal powders tested have been classified as more explosive than the coal and other carbonaceous dusts that have been responsible for many serious explosions in the past. Present experience indicates that essentially the same factors that affect the flammability of carbonaceous dusts must be considered in determining the explosive properties of metal powders.

### Dust Ignition and Flame Propagation.

The ease with which a dust cloud may be ignited and the rate at which flame will propagate through the cloud from the point of ignition depend to a large extent on the size of the dust particles, as well as on the density of the cloud and other conditions. Physicists have pointed out that in general (1) the finer the dust the more flammable it is; (2) the finer the dust the smaller the flame or spark required to ignite it; and (3) the finer the dust the longer it remains in suspension in air, where it can be most readily ignited. There are many other factors, however, that must be considered in any study to determine the relative flammability of a dust or the seriousness of a dust-explosion hazard in an industrial process. In testing carbonaceous materials the percentage of ash and the amount of volatile matter may indicate the relative flammability of the dust sample. Other factors that must be considered in virtually all dust-explosion tests are the shape of the dust particle and the moisture content; the ease with which the dust can be dispersed to form a cloud; the uniformity of size of particles forming the cloud; the density of the dust cloud; the uniformity of distribution or spacing of the particles; the presence of an ample supply of air or oxygen to support combustion; the size or nature of the ignition source; and the ease of oxidation of the dust particles.

The rate at which any substance will oxidize or burn depends on the surface exposed to the oxygen of the air, and when any solid substance is disintegrated into dust its surface area is increased enormously. This increase in surface area can be illustrated by dividing a cube into smaller cubes. A 1-inch cube presents 6 square inches of surface, but if this solid block is divided into smaller cubes with each side measuring 1/100 inch there will be 1,000,000

cubes with a total exposed surface of 600 square inches. A further reduction to 1/1000-inch cubes would increase the surface to 6000 square inches. One investigator has estimated that 1 pound of some of the finest metal powders has an expanded surface of about 220,000 square inches.

Experiments show that the ignition temperature of some dusts drops rapidly as the size of the particle is reduced. In reporting the temperature of ignition of various dusts, Price and Brown* showed that a sample of cork dust, about 90 per cent of which would pass through a 200-mesh screen, ignited at 1080° C., while a sample that completely passed through the 200-mesh screen could be ignited at 975° C. Similarly a sample of starch with 80 per cent passing through a 200-mesh screen ignited at 1035° C., while the sample that completely passed through the screen could be ignited at 960° C. The ignition temperature of 150-mesh coal dust is 50° C. lower than that required to ignite 48-mesh samples. Although Beyersdorfer does not give the particle size, he reports 485° C. as the ignition temperature of aluminum powder and 230° C. as the temperature at which fine aluminum grindings can be ignited.‡ Additional research on this subject with metal dust is being planned.

In still air the rate at which dust particles will settle is directly proportional to the density of the particles and the square of their radius. In industrial plants, air currents may tend to keep small particles in suspension indefinitely and thus build up an explosive dust-and-air mixture which presents a constant hazard. Experiments have shown that flame propagation occurs most readily in dust clouds in which the particles are small, of uniform size, and uniformly distributed. Under such conditions flame velocities of 2000 to 3300 feet per second have been measured, with indications of much higher velocities, probably greater than 6000 feet per second.

## Metal Powder Production.

There are a number of different methods of producing metal powders, and the different processes are being improved from time to time. There are also variations in the different processes to allow the manufacture of different types of powder particularly suitable for special purposes. A list of the more important processes includes atomization, chemical precipitation, condensation, electrolytic deposition, machining, milling, and reduction. Except where the powder is produced or handled in dry form, there is no dust-explosion hazard in connection with the manufacturing operation.

In the atomizing process, the molten metal is forced through an orifice or nozzle, where it is struck by a jet of steam or compressed air or gas, and as the metal solidifies in the form of a fine powder it is carried along with the air

*Price, D. J., and Brown, H. H., Dust Explosions: National Fire Protection Association, Boston, Mass., 1922, pp. 14-15, table I.

‡Uber den Begriff Feuergefährlichkeit: Ztschr. Tech. Physik., vol. 9, No. 1, 1928, pp. 17-19.

**One life was lost when an explosion of aluminum powder wrecked the spreading and dust collecting equipment on this press.**

or gas stream to the collecting equipment. Explosive concentrations are generally present both in the ducts carrying the air and dust stream and in the dust collector.

Both dust and gas explosion hazards are present in the condensation process which is used principally in the production of zinc and lead powders. The vaporized metal is reduced in an atmosphere of carbon monoxide and passed through a condenser. The rate of cooling determines the size and type of powder produced.

Machining is the process generally employed for the production of magnesium powder because of the difficulty experienced in preventing dust ignitions or explosions in other processes. Machining may be described as a large-scale or mechanized filing or cutting process, and the explosion hazard exists wherever quantities of the dust or powder produced are in suspension in air during preparation or handling.

Probably the most widely used method of producing metal powders is the milling process. The generally accepted term includes the production of powder in stamps, crushers, rolls, ball, bar, and disk mills, attrition mills, eddy mills, and jet pulverizers. In the last two types of equipment air currents are employed in the grinding operation, and in all of the other types there is enough air movement to create dust clouds within or around the milling equipment during normal operation.

Two methods of milling designed to reduce the explosion hazard have been developed. One method, known as the Hall process, provides for the mixing of a liquid with the material entering the mill to form a slurry or paste and thus eliminate dust ignitions within the mill. The explosion hazard is still present to some extent if it is necessary to dry or further condition the product after milling. The other method, known as the Hametag process, employs a stream of inert gas to carry the powder away from the mill as it is produced. The purpose is to prevent both oxidation and explosions. Fairly effective protection against explosions can be obtained in certain instances where an inert gas can be found that is effective in preventing ignition of the powders being produced and can be used to carry the materials to the collectors or separators.

Metal powders are produced in a wide range of sizes, and different processes produce differently shaped particles. Certain types and sizes are better suited than others for particular uses. For instance, a flaked powder is desired for making aluminum paint, while angular particles are better for some forms of powder metallurgy. Very fine particles are necessary for making inks used for fine surface printing, decorating, or lining, and here again flaked powders produce better leafing or coverage. Although very coarsely divided metal in the form of shot sometimes is referred to as powder, it seems desirable, at least in discussing explosion hazards, to include only the commonly marketed sizes that may be ignited as a dust cloud. Under such classification the particle size of dusts considered explosive would extend from the 30-mesh magnesium used in pyrotechnics to the 400-mesh-and-finer bronzing powders used in high-grade printing inks. Some of these finer powders are reported to have a thickness of about 0.4 micron.

In connection with metal-powder production, screening and packaging operations constitute dust ignition hazards similar to those in other dusty industries employing the same type of equipment. Screens, bolters, sifters, reels, dust collectors, and similar machinery are required to make the necessary size separations, and generally some dust clouds are formed in or around packaging machinery.

### Powder Metallurgy.

The present stage of development of the fabrication process in which the metal powders, either singly or mixed, are pressed to the desired shape apparently presents a limited explosion or dust-ignition hazard. Hydraulic, toggle, cam, and other types of presses may be employed provided they are capable of producing the necessary pressure. The pressure used ranges from a few tons to more than 100 tons per square inch. The die parts are of hardened tool steel. The swagings now being produced are generally small, and the powder required for the individual pressings, may weigh only a few ounces. However, pieces weighing 40 pounds or more have been produced, and large quantities of powder may be stored in the hoppers or bins of the automatic presses from

which it is fed in the desired amount to the die or mold. The ignition hazard is present while a bin or hopper is being filled with the powder or when failure of the feeding mechanism or spills create a dust cloud around the press.

Following the pressing operation the parts are sintered or heat-treated for a short time. Because the material is no longer in powdered form there is no dust-explosion hazard in this operation. Some attention has been given to the possibility of eliminating this step in the process by hot pressing. Additional sources of ignition may be introduced in providing for hot pressing, and additional care will be necessary to prevent the metal powders that ignite at relatively low temperatures from coming in contact with highly heated parts of the press while they are in the form of a cloud.

### Flammability of Metal Powders.

Aluminum powder has been produced in large quantities for many years. Increased use of aluminum paint stimulated production of the powder, and a number of serious explosions in connection with the production of the powder directed attention to the hazard of dust ignitions. Extensive laboratory tests have been made to determine the ignition temperature, limits of concentration, and other factors that would indicate the extent of the hazard and aid in the development of protective measures. Ignition has been reported at temperatures as low as 230° C. and references have been made by investigators to ignitions of dust clouds by glowers, induction coil sparks, electric arcs, and mechanically produced heat. It is known that sparks from a piece of steel in contact with a grinding wheel are capable of igniting a cloud of aluminum powder.

Research to determine the flammable and explosive properties of other metal powders has been quite limited, and there is a paucity of published data on the subject. A number of tests have been made in the Bureau of Mines laboratories at the request of producers or users of certain types of metal powders to determine their relative flammability. These tests are designed to indicate whether the material is more or less explosive than coal dust, comparison being based upon the amount of inert dust that must be added to suppress ignition. The dusts so tested include several types of iron powder, several types of magnesium powder, zinc powder, and tin powder. All of these dusts were found to be explosive. Ignitions were obtained by blowing samples of dust into a furnace operated at temperatures ranging from 425° C. to 660° C., and by using an induction-coil spark as the source of ignition in a tube through which the dust was blown. The amount of inert material it was necessary to add to some of the samples to suppress ignition ran as high as 97.5 per cent. With the sample of Pittsburgh coal dust used as a standard or check, the addition of 65 per cent inert material was necessary to suppress ignition. Additional tests are now under way, and an effort is being made to obtain data on the lower limit of concentration at which ignitions can occur.

**A dust explosion wrought this destruction at an aluminum powder producing plant.**

Further research will be necessary to determine the possibility of initiation of ignitions by discharges of static electricity and to determine the hazard due to accumulation of electrical charges on the dust particles. As Gibbs points out in his reference to the work of Rudge frequently mentioned in his book,* nearly all dusts become electrically charged when they are blown about in the air and, as the charge resides upon the surface, the capacity of the dust is proportional to the total surface area. As previously pointed out, the finer the dust the greater the surface area and therefore the greater the charge. In the table developed by Rudge after testing nearly 200 different dust samples, the character of the charge detected on different dusts is indicated, and it is interesting to note that the charge found on aluminum, iron, magnesium, tin, and zinc was negative in each instance. In his report on these tests‡ it is pointed out that, although many exceptions were noted, it seemed to be fairly well established that (1) non-metallic elements give positively charged clouds when the dust is blown into suspension, and (2) metallic elements give negatively charged clouds when finely divided material is blown into suspension in air. Further research to determine the possible effect of the electrical charge present on dust particles in determining their explosibility would seem to be warranted.

*Gibbs, W. E., The Dust Hazard in Industry; London.

‡Rudge, W. A. Douglas, On the Electrification Associated with Dust Clouds: Phil. Mag., Ser. 6, vol. 25, pp. 481-494.

### Protection Against Explosions.

At this time it is difficult to make specific recommendations for providing protection against ignitions of metal powders because, as previously pointed out, very little information is available on the factors that affect the explosibility of such materials. It can be assumed, however, that in general the safety codes developed for protection against dust explosions in other industries will be applicable in plants handling the metal powders used in powder metallurgy. Where it is not possible to provide absolute protection against dust ignitions owing to lack of knowledge concerning the flammability of the product or because of necessary manufacturing conditions, some degree of protection can be provided that will greatly minimize the results of such ignitions and reduce the hazard to life and property. Reference has been made previously to the safety codes for preventing dust explosions developed by the N.F.P.A. Committee on Dust-Explosion Hazards, and particular attention is called to the code for the prevention of dust explosions in the manufacture of aluminum bronze powder, and the fundamental principles for the prevention of dust explosions in industrial plants. These two codes and the articles on the release of explosion pressure through properly located vents* contain a number of recommendations for providing protection against dust explosions; the principal ones may be summarized as follows:

1. Segregate hazardous processes in small detached buildings or separate units with fire walls and fire doors.
2. Provide vents such as light roofs or large hinged window areas designed in the proper proportion to release explosion pressure without structural damage.
3. Maintain equipment as nearly dust-tight as possible and provide for frequent cleaning to prevent accumulation of dust at points where it may be thrown into suspension to form a cloud.
4. Eliminate all possible sources of ignition by using:
   (a) Electrical equipment approved for such locations.
   (b) Indirect heating to prevent dust collecting on heated surfaces.
   (c) Ground connections on all equipment to remove static electricity.
5. Use inert gas to prevent dust ignitions wherever feasible.
6. Use conveying, collecting, processing and cleaning equipment designed to perform its function with no possibility of producing metallic sparks or frictional heat capable of igniting the powder being handled.
7. Provide fire-fighting facilities of the type found best adapted to the particular needs of the plant.

Note: Water and ordinary types of fire extinguishers are not effective on metal-powder fires, and in many instances their use will intensify the fire. They

*Brown, Hylton R., and Hanson, Richard L., Venting Dust Explosions: N.F.P.A. QUARTERLY, April, 1933.

should be rigidly excluded from sections of the plant where their use by inexperienced persons would be dangerous. Disturbance of quietly burning powder by hose streams or other means may cause a serious explosion. Dry sand, talc, rock dust, and similar materials have been used to smother small fires in metal powder, but fine graphite is much more effective and is now generally recommended. A special fire-extinguishing powder has been developed for use on magnesium fires. All such inert substances must be applied carefully to avoid any disturbance of the burning material likely to throw it into the air, and the use of this method should be attempted only by a person familiar with the hazard. No satisfactory method of extinguishing metal-powder fires too large to be covered with powder is now known, and experienced operators usually prefer to seal a fire in the unit in which it started and permit it to burn itself out.

## Conclusion.

Powder metallurgy is an industry in which at present the art is ahead of the science, but as developments continue, additional data on the properties of the different powders no doubt will be available. Our present knowledge of the factors affecting the explosibility of the dusts is likewise limited, but the simple fact that the dusts are explosive as shown in preliminary tests should be sufficient justification for the adoption of all known precautions to prevent ignitions wherever such dusts or powders are produced, processed, or handled. Producers and users of metal powders are urged to coöperate in making available to the industry experiences or data that will contribute to the development of safe practices for explosion and fire protection and thus eliminate or reduce this hazard to life and property.

# Artillery Ammunition Manufacture.

By Arthur B. Guise and J. S. Slicer, Jr.,

Inspection Department, Associated Factory Mutual Fire Insurance Cos.

In the N.F.P.A. Proceedings for 1917 will be found an article entitled "Ammunition Manufacture," by W. D. Milne of the Underwriters' Bureau of New England. The United States and Canada are again engaged in the large scale production of munitions, and industrial plants of many types must deal with unfamiliar fire and explosion hazards in addition to the fire hazard resulting from increased production with familiar processes. In some respects there has been little basic change in manufacturing devices such as the shrapnel combination time and impact fuse.

This discussion is limited to the manufacture of artillery ammunition as carried out in the average industrial plant and does not cover the manufacture of explosives or the hazards that are inherent in the handling and processing of large quantities of explosives.

Among the factors tending to increase the fire hazards in plants where the manufacturing of ammunition is not a normal process are:

1. Introduction of unfamiliar processes and the hazards that accompany them.
2. Unsuccessful manufacturing operations and accumulation of rejected products.
3. Increased hours of plant operation.
4. Lack of proper attention to cleanliness and maintenance.
5. Labor difficulties.
6. Enemy interference and incendiarism.

The demand for military ammunition comes from Great Britain as well as from the United States Government, so that increased production of ammunition is expected. With this increase will come an increase in the "human element hazard," especially where inexperienced workers are used on special processes.

The processes in ammunition manufacture are many and the individual plant will ordinarily work with only a small part of the completed ammunition. Many plants that would not ordinarily be considered in the ammunition classification are therefore liable to increases in the fire hazard in varying degree.

The different classes of plants, and their products, in which we will find work being done on parts for military ammunition are in part as follows:

1. Steel mills (steel bars for projectiles).
2. Brass mills (cartridge cases).
3. Screw machine shops (fuses, etc.).

4. Machine shops (machining projectile forgings).
5. Forge shops (forging projectile cases).
6. Various metal workers (balls for shrapnel).
7. Pressed metal work (powder tubes).
8. Powder mills (powder and powder pellets, fulminate caps).
9. Watch and instrument factories (anti-aircraft fuses).
10. Woodworkers (shipping cases).
11. Paper tubing plants (shipping containers).

Although some factories may combine several of these operations, in many cases the work is still further subdivided.

In the manufacturing operations for combination time and impact fuses and in the loading of the shrapnel bursting charge the use of black powder offers certain hazards resembling those of hazardous dusts. It is recommended that hoppers be vented to the outside and rooms provided with explosion vents. Collecting ducts for black powder dust should be equipped with water wash arrangements such as are used to remove magnesium grindings near the grinding wheel.

Many of the recommendations for explosion venting, etc., are based on the study of means of preventing and alleviating dust explosions which has been carried on in the 20 years since the first World War. Tests made with fine grain black (FFF) blasting powder burning unconfined indicate that the severity of the suddenly developed pressure is comparable with a cornstarch dust explosion when one lb. of black powder burns per 800 cu. ft. of room volume and the venting ratio is 50 cu. ft. of room volume per sq. ft. of vent area.

## Classes of Military Ammunition.

Military ammunition divides itself into two general classes, depending on the size or caliber of the gun for which it is made. The first class, artillery ammunition, means ammunition used in guns of 37 mm. caliber or over. The second class, small arms ammunition, applies to 0.30 and 0.50 caliber ammunition and is not covered in this discussion.

Artillery ammunition is further divided into three classes (1) fixed, (2) semi-fixed, and (3) separate loading (or unfixed), according to the method of assembly and the loading into the gun.

Fixed ammunition, as the name implies, has all of its parts assembled into one unit and it is shipped and loaded as a unit. This type of ammunition is used in the guns of 4.7-inch or 105 mm. calibers and smaller.

In semi-fixed ammunition the parts are usually shipped and loaded as one unit, but it is so made that the projectile may be removed to change the propelling charge in the cartridge case. This type of ammunition is used in light and medium howitzers as an additional means of varying the range of the gun.

*National Defense Advisory Commission, Photo by Palmer.*

**75 mm. cartridge cases being trimmed by an accurate machine between draws. The production line is moving at top speed at the Frankford Arsenal in Philadelphia.**

Separate loading ammunition is used in all the larger caliber guns and howitzers such as the 155 mm. and greater. In this type of ammunition the projectile and the propelling charge are shipped and loaded in the gun as separate units.

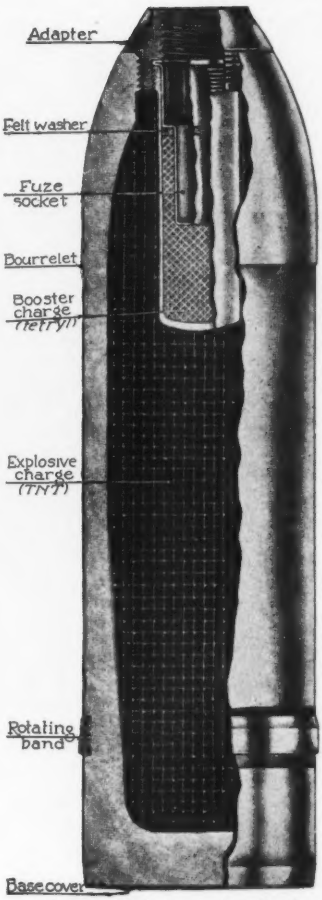
Any complete round of ammunition is made up of several distinct parts that require entirely different processes in their manufacture. These parts are:

(1) Projectile.
(2) Cartridge case, or cartridge bag (propellant containers).
(3) Primer.
(4) Fuse.

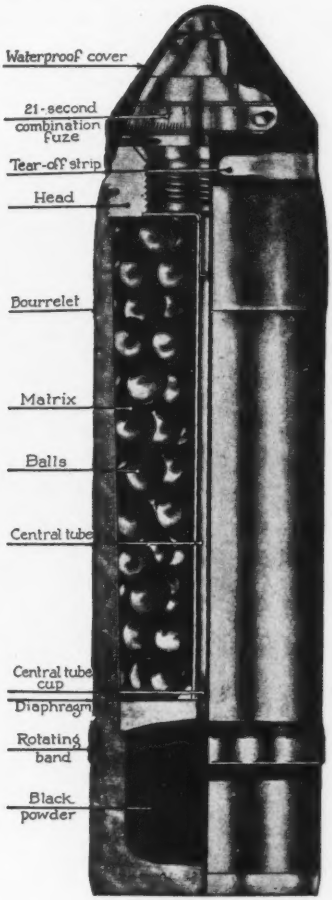
### I. Projectiles.

Shrapnel and high explosive shells are used in greatest number and chemical shells are least used. Shrapnel shells are always fused at the point and the fuses are of the combination type (except where shrapnel is used for anti-aircraft work).

High explosive shells may be fused either at the point or at the base. When fused at the point, fuses may be either of the impact, time, or the combination type, but when fused at the base the fuses are always of the impact type.




75 mm. High Explosive Shell.

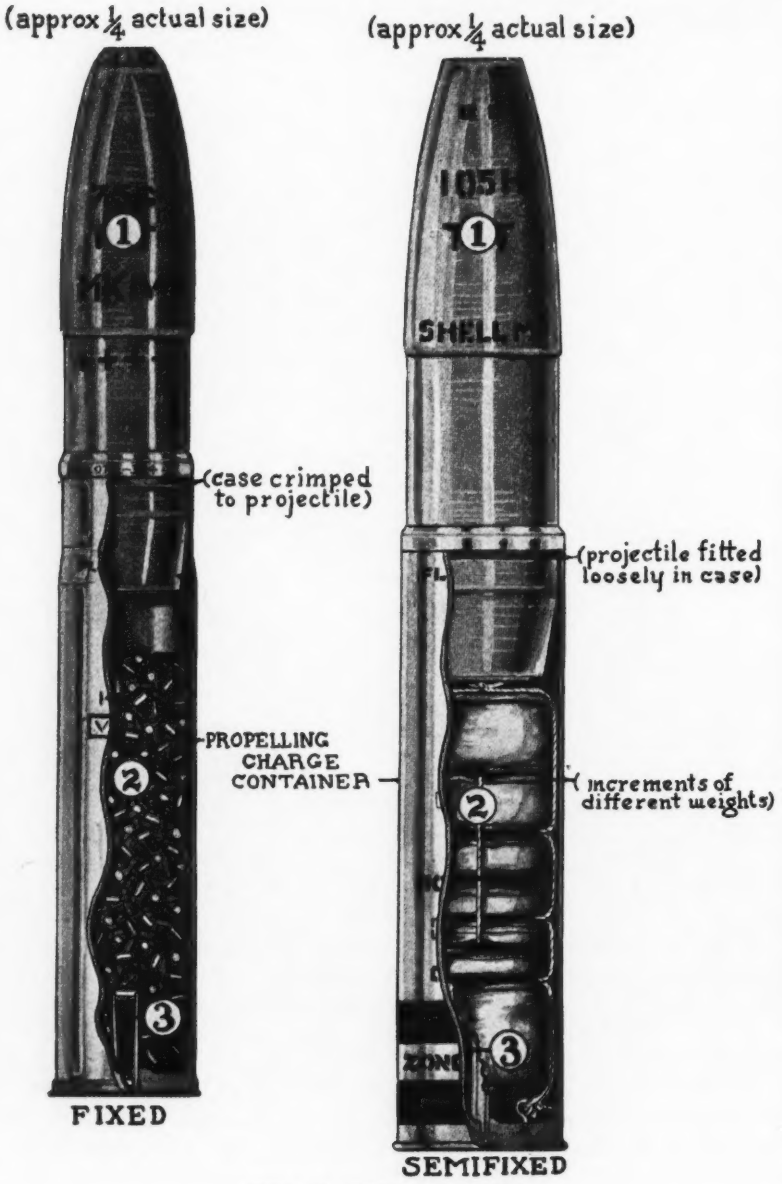



75 mm. Shrapnel.

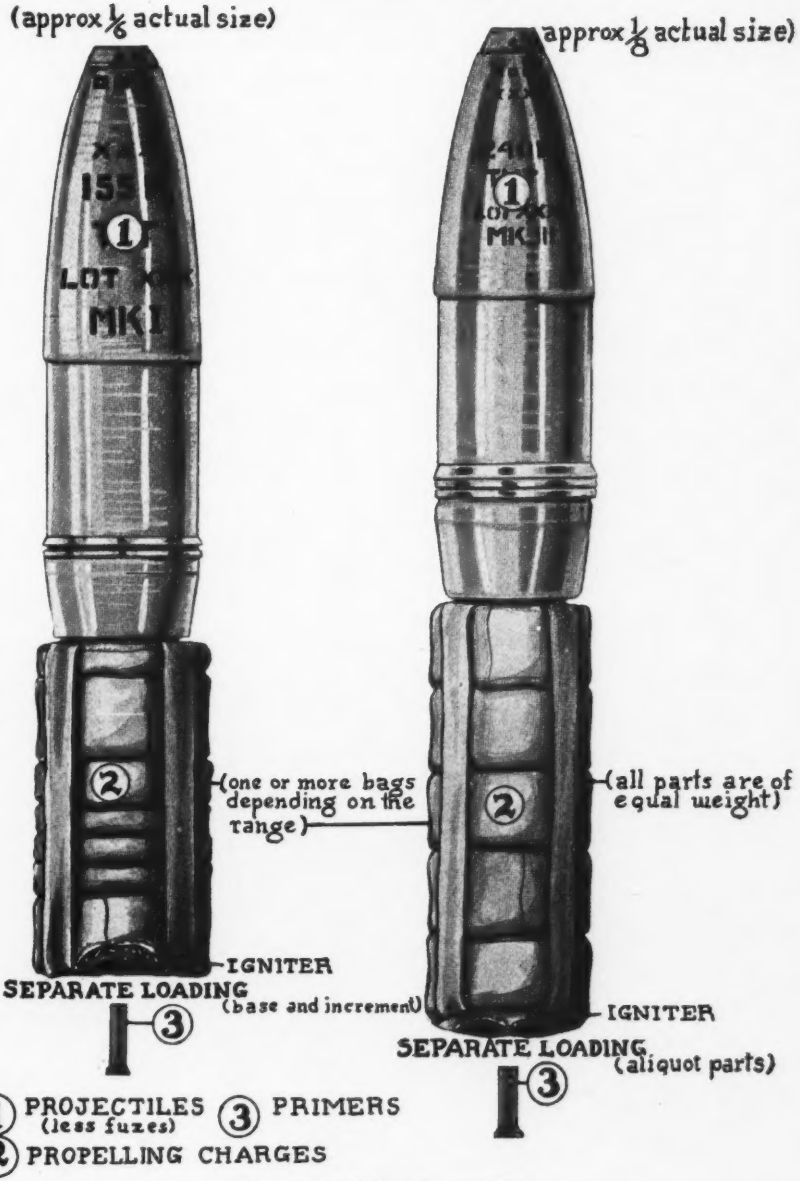
The accompanying illustrations show a typical shrapnel projectile for a 75 mm. gun, and a point-fused high explosive shell.

**(a) Shrapnel.** The shrapnel projectile is a hard steel case filled with hard lead balls about ½ in. diameter, with a small black powder charge to expel the balls at a time determined by the setting of the fuse.

Shrapnel projectile cases are forged by piercing from the nose end, heat-treating, machining and painting. In none of these operations are other than ordinary hazards encountered. The major fire hazards are in connection with the heat-treating furnaces and the quenching of the projectile in oil.




Types of Artillery Ammunition.




Types of Artillery Ammunition.

The majority of fuel oil fires result from the use and not the storage of the fuel oil. Many fires occur at and about fuel oil burners because of the use of makeshift piping and flexible connections made with rubber hose. The standards for oil burner installation should be carefully observed, with particular attention to safeguarding piping against mechanical injury, use of proper fittings, flexible connections of proper type, etc.

Quenching oil tanks should be designed with a large factor of safety in the arrangements for cooling the oil. Recent fire experience indicates a considerable increase in quenching oil fires in general because of increased production rates and consequent overheating and ignition of the quenching oil.

First aid fire extinguishing equipment of the proper types should be provided for the extinguishing of fires around fuel oil fired heat-treating furnaces and around quenching tanks. The number and size of the extinguishers can be determined only by the size of the hazard, but estimates as to the necessary amount of extinguishing material should err on the side of too much rather than too little.

Where the entire body of quenching oil does not exceed a temperature of 250° F., foam and water spray nozzles may be safely applied for the extinguishing of a fire. Where the entire body of the oil is over 250° F. in temperature, the application of extinguishing materials containing water may cause the oil to "foam over" and spread the fire, and therefore carbon dioxide or dry chemical extinguishers should be used instead. In some cases, foam and water spray nozzles are not desirable extinguishing equipment because the water in the oil may cause hard spots on the surface of the steel parts. In these cases also, carbon dioxide or dry chemical extinguishers should be provided.

Prior to painting, the shell cases are cleaned to remove cutting oil. The use of vapor degreasers employing a non-flammable solvent offers much less hazard than the use of flammable liquids such as gasoline or safety solvent.

Projectile cases are painted inside and out and the methods used offer nothing new in the way of fire hazards. The projectile cases are placed on a conveyor which passes through a spray booth in which the inside and the outside surfaces are coated in one operation. The conveyor then carries the cases into a drying oven.

Projectiles are not usually filled in the plant in which they are manufactured.

The metal parts used in the charging of shrapnel projectiles are the powder tube which carries the flash from the fuse to the base charge of black powder and the diaphragm which covers the powder pocket. The powder tubes may be either seamless drawn brass or steel and are made in brass mills or pressed steel plants. The manufacturing processes involve no unusual fire hazards. The diaphragm is a steel forging, machined and drilled with a central hole to receive the powder tube.

The effective charge of a 75 mm. shrapnel projectile consists of approximately 270 one-half-inch lead balls, held in place with rosin or other smoke producing matrix. The bursting charge consists of about 3 oz. of black powder in the base of the projectile.

In filling the shrapnel cases, the powder tube is assembled to the diaphragm and the assembly firmly seated on the shoulder in the interior of the projectile case, which leaves a powder cavity in the base of the projectile. The lead balls are then placed in the case, shaken down, and covered with molten rosin. After the mass has thoroughly cooled, the rosin is faced off to the proper depth to permit seating of the steel fuse adapter.

The rosin filling process involves the fire hazard of handling a flammable material at a relatively high temperature, and may be compared with the resin cooking processes carried out in paint and varnish plants.

A gas or fuel oil heated kettle of molten rosin is usually arranged to discharge to a secondary gas-heated reservoir at the bench where the rosin flows into the projectiles. Once melted, the rosin remains fluid at a fairly low temperature.

The rosin kettles should be thermostatically controlled to prevent overheating and consequent ignition. Because thermostatic controls occasionally fail to operate, a high temperature limit control, set to operate at a temperature about 10° to 15° above the maximum needed, should also be provided. Kettles and secondary reservoirs should be vented to the outside by means of hoods and ductwork. To prevent damage to the ductwork from possible ignition of deposits, sprinkler, spray nozzle, or carbon dioxide protection should be provided. Where sprinklers or spray nozzles are used for protection of the ducts, baffles and drains should be provided to prevent water from getting into the rosin kettles. The ventilating ducts should be spaced and insulated where they pass through combustible walls, floors, or roofs. Electrical equipment exposed to the fumes from the kettles or the reservoirs on the benches should be of vaportight type.

The bursting charge loading operation is rarely handled in the average industrial plant, but is usually carried out at an arsenal.

Loading operations should be carried out in buildings separated from main buildings and with rooms separated from one another by heavy partitions. Rooms should be provided with explosion venting windows. The roof should preferably be arranged to lift under internal pressure of 25 lb. per sq. in.

Only the operator should be allowed in the loading room. A minimum quantity of powder should be permitted in the room and the floor and benches should frequently be cleaned of powder which may have escaped.

The bursting charge is weighed, a funnel inserted in the central tube, and the powder poured into the base cavity. This operation should be performed behind a barricade for the protection of the operator.

The shell is inspected for proper loading by inserting a rod, and extreme care must be exercised to avoid igniting the charge by friction.

Non-sparking tools should be used wherever powder loading operations are carried out.

**(b) High Explosive Shells.** The manufacture of the projectile cases for high explosive shells is similar to the manufacturing processes used for the production of shrapnel projectile cases. Accordingly, the same fuel oil and quenching oil fire hazards are involved. However, the loading of the high explosive projectiles will always take place at an arsenal or other special plant, because large quantities of explosives are required.

Armor piercing projectiles are always base-fused. The cases are thick-walled and accordingly the armor piercing shell contains relatively only a small amount of explosive.

**(c) Chemical Shells.** Chemical projectiles are similar to the high explosive projectiles except that they are filled with gas or smoke producing chemicals. Both liquid and solid chemicals are used. The shells are burst by a small high explosive charge.

### II. Cartridge Cases.

**(a) Fixed Ammunition.** Cartridge cases are made from brass containing about 70% copper. Cartridge cases for artillery ammunition are generally manufactured in brass mills or press works having heavy equipment and facilities for annealing.

The annealing furnace is generally oil-fired and may have the same hazards discussed for oil-fired furnaces under the heading "Shrapnel Cases," although special atmosphere furnaces may be used in some cases.

**(b) Semi-Fixed and Separate Loading Ammunition.** Cartridge bags or powder bags are used in both the semi-fixed and separate loading ammunition. These bags are made of a special raw silk, commonly known as cartridge cloth, which burns without leaving a residue. Bags made of cotton cloth and similar fabric may leave burning or smoldering fragments after the explosion of the powder. The fire hazards involved in the manufacture of the cartridge bags are those found in ordinary silk processing.

### III. Artillery Primers.

An artillery primer is virtually a blank cartridge and is used to ignite the propelling charge in the round of ammunition. In fixed and semi-fixed ammunition the primer is a percussion primer and integral with the cartridge case. In the separate loading ammunition, the primers are inverted in the breach block and may be friction, electric, or percussion fired.

Primers are usually made with a detonating pellet and either granular or compressed black powder enclosed in a metal case. The amount of black powder in the primer may vary from 20 to 110 grains. The loading of primers

should be done only in a room partitioned off for the purpose, and the supply of powder should be kept to the smallest practical working amount. Explosion venting windows should be installed. The flooring should be seamless, free from nails, and should be kept free of powder dust.

The primers may be loaded by placing a measured charge by hand in the primer and closing and clipping the closing disk, or the powder may be drawn through a measuring device directly from a powder reservoir. If a powder reservoir is used, it should be of heavy steel plate, cone-shaped, and at least 3 ft. high and 2 ft. in the largest diameter. This reservoir should extend through the roof and be covered to prevent powder from depositing on the roof and to keep moisture and dust from entering.

The workbench should be zinc, copper, or lead covered, and should be provided with a marginal trough in which water may be placed.

The primary hazard of primer loading does not lie so much in the amount of powder usually present in the workroom, but in the possible accumulation through carelessness of powder dust on the floor cracks or other out-of-way places.

## IV. Fuses.

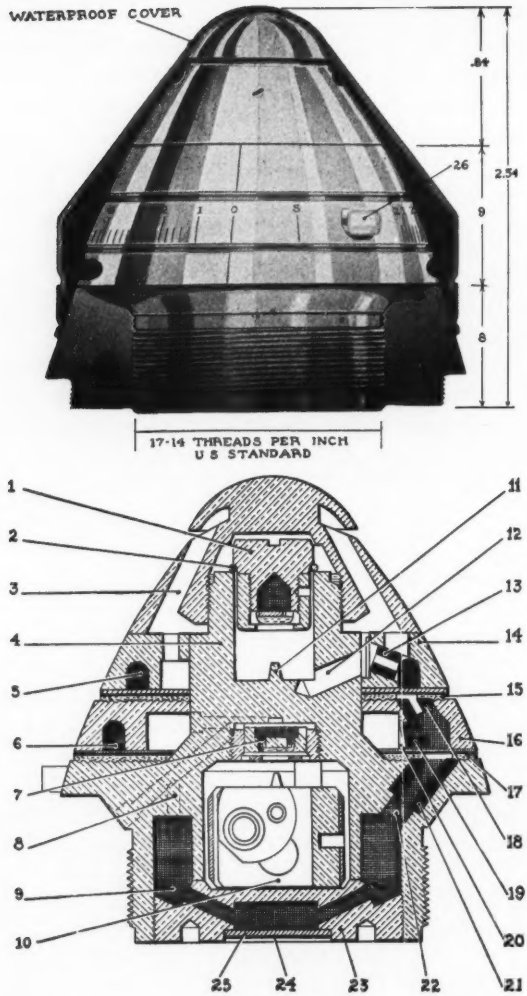
Fuses are divided into various classes as outlined below:

A. Fuses in the Base of the Projectile.
   1. Impact operation.
      (a) Non-delay.
      (b) Short delay.
      (c) Long delay.

B. Fuses at the Point of the Projectile.
   1. Impact Type.
      (a) Superquick.
      (b) Supersensitive.
      (c) Non-delay.
      (d) Short delay.
   2. Time.
      (a) Powder train type.
      (b) Mechanical type.
   3. Combination Fuses Embodying Certain Combinations of the Above Types.

Armor piercing projectiles are always base-fused, as are some of the other high explosive types.

Shrapnel is usually point-fused with a combination powder train timer and impact detonator (only time fuses are used if shrapnel is used for anti-aircraft purposes). High explosive shells for anti-aircraft use generally are provided with mechanical time fuses and are not armed for impact firing for




Combination Fuse.

1. Concussion plunger.
2. Concussion resistance ring, brass.
3. Vents in closing cap.
4. Body, bronze.
5. Upper time train, compressed powder.
6. Lower time train, compressed powder.
7. Percussion primer.
8. Vents leading from percussion primer to magazine.
9. Powder magazine.
10. Percussion plunger.
11. Firing pin, brass.
12. Vent leading to upper time train.
13. Compressed powder pellet.
14. Upper time train ring, tobin bronze.
15. Washer for graduated time train ring, felt cloth.
16. Graduated time train ring, tobin bronze.
17. Washer for body, felt cloth.
18. Compressed powder pellet in vent leading to lower time train.
19. Compressed powder pellet in lower time train vent.
20. Brass disk, crimped in place.
21. Compressed powder pellet in vent leading to magazine.
22. Vent leading to magazine.
23. Bottom closing screw, brass.
24. Washer for closing screw, brass.
25. Washer for closing screw, muslin.
26. Rotating pin, brass.

this use. Therefore, the shells will not explode if the timer should not operate, and the shells fall back to the ground.

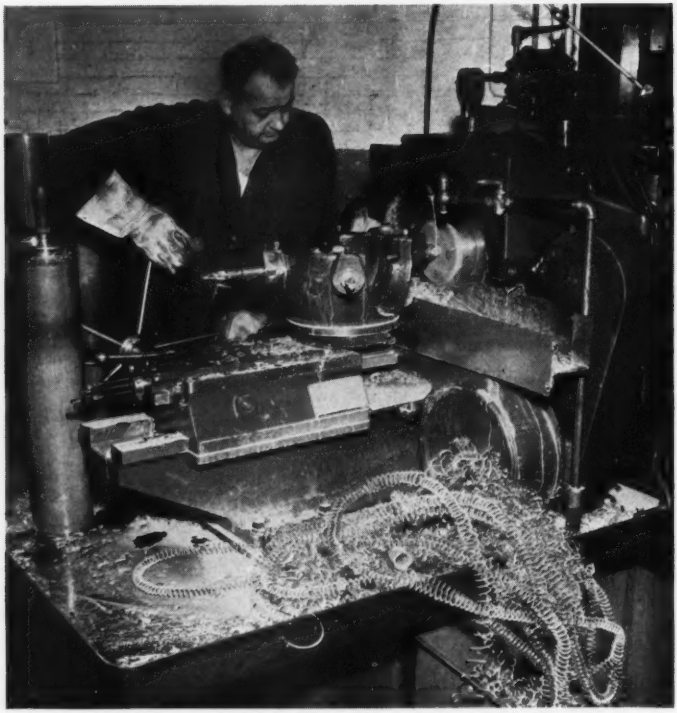
A typical combination powder train timer and impact fuse such as is used on shrapnel shell is illustrated on the opposite page.

When the fuse is set at zero the action when the shell is fired is as follows: The concussion plunger (1) will slip through the resistance ring (2) due to the inertia of the plunger. The concussion primer, which is in the concussion plunger, is detonated by the firing pin (11). The flames from this primer pass through the vent (12) and ignite the powder pellet (13) which is in the upper time train ring. The flame from the powder pellet is transmitted to the compressed powder pellet (18) located in the lower time train ring (6). The flame from pellet (18) ignites pellet (21), which explodes the magazine charge (9), from which the flame passes through the central tube of the shrapnel shell to the base charge. Powder trains (5) and (6), which enter into the time feature, are not involved in the action just described.

For time settings, the action is as follows: The vent (18) has been changed in position with respect to vent (22) which leads to the powder magazine (9). The flame in this case passes through vent (12) and burns along the upper time train in a counterclockwise direction until vent (18) is reached, where it passes down to the lower time train and burns back in a clockwise direction to the position of vent (22), where it is transmitted by the pellet of compressed powder (21) to the powder magazine (9).

This fuse will also function on impact. The percussion firing pin is armed by centrifugal force, that is, the firing pin is unlocked and revolves to the armed position when the the shell revolves on firing. In the armed position, the firing pin will detonate the percussion primer (7), the flame from which passes through vent (8) to the powder magazine (9). When projectiles having a fuse of this type are shipped, the fuse is set at safety to the mark (S) on outside of fuse. At this setting the solid metal section of the upper time train completely covers the compressed powder pellet (18) in the lower time train and the solid metal of the lower time train completely covers the compressed powder pellet (21) which connects with the magazine charge (9). This setting completely eliminates the time action and since the percussion plunger is normally locked in the unarmed position and cannot strike the percussion cap unless it has been previously released by the centrifugal force resulting from revolving at over 1000 r.p.m., there is practically no danger of these fuses being actuated from a jar such as might be received during shipment.

(a) **Manufacture of Combination Fuses.** The upper and lower time train rings contain a powder train when complete. The brass blanks for these rings are cut out, turned, and bored to fit the stem of the body, and an annular groove is cut for the powder train. The graduations are cut on the exterior



*National Defense Advisory Commission, Photo by Palmer.*

**Machining the head of the case, one of the last processes in making anti-aircraft cartridges. This picture was taken in the Washington Navy Yard.**

surfaces. The surfaces in the grooves, vents, and magazines, which come in contact with powder, are lacquered.

The annular grooves on the under side of the time train rings furnish the time feature of the fuse as previously described. These grooves are filled with loose, very finely divided, black powder and compressed at about 68,000 lbs. per sq. in. Owing to the finely divided state of the powder used, special precautions must be taken to guard against the obvious hazard in accumulations of its dust. The loading of these rings should be done in specially arranged rooms.

The following precautions should be taken in the loading of these fuses:

1. Each press with its accompanying work tables should be in a separate or partitioned-off room. The press should have a barricade to protect the operator, with a steel plate door in front which must be closed before pressure is applied. Presses should be driven by conductive belting, with motors either outside or explosion proof.

2. Such rooms should have seamless floor coverings over all, and extending up the walls to allow clean sweeping. Sheet lead is said to have been used with unsatisfactory results.

3. Employees should be required to wear only conductive rubber shoes or nailless shoes.

4. The rooms should be lighted by well-guarded explosion-proof lights or by lights located outside of windows. Electrical equipment should be of the explosion-proof type, or switches and fuses should be located outside of the rooms.

5. The rooms should be heated indirectly, with filters to prevent powder dust from being drawn into the system. The filters should be frequently cleaned by washing in water.

6. The relative humidity of the rooms should be maintained at about 45%. All equipment and bench tops should be electrically grounded.

7. A blower system taking suction near the jaws of the press and from an opening near the floor should draw air for the collection of the powder dust. The powder dust should be wet by water sprays placed in the ductwork.

8. Waste powder should be constantly removed from the floor, tables, and walls, and placed in a covered tank freshly filled with water. The tank should be emptied frequently, into a stream if possible.

9. Windows of small rooms should be explosion-venting and glazed with wire glass and precautions should be taken to guard against flying glass in case of an explosion. There should be at least two exits from each room.

10. Powder should be brought in in closed 1-lb. containers of non-ferrous metal, plastic material, or rubber, and not over three containers should be allowed in a room at any one time.

11. These rooms should be equipped with automatic sprinklers on 10-ft. spacing.

12. Workmen should have pocketless coveralls and should be required to deposit all matches on entering the restricted area.

13. Extinguishers of the soda-acid or water-filled carbon dioxide cartridge types should be provided in each room and also outside of each entrance.

14. Fire drills should be held frequently.

15. The filled rings should be removed from the rooms promptly to prevent too great an accumulation of exposed powder.

The greatest hazard in the pressing operation is the danger of panic or injury to employees who become frightened at the flash of a small amount of powder. A serious explosion, such as might damage building or piping and cause serious injury to a number of employees, is probably remote if the proper precautions are taken and the powder dust not left to accumulate to a hazardous degree.

After the powder train has been pressed into the brass rings, the rings are lacquer sprayed and the powder bearing surface faced. Milling machines are used to do this work and they may face 15 or more rings at a time. By this process, brass chips with powder mixed in are taken off, and the hazard from powder dust is the same as in the loading process.

*National Defense Advisory Commission, Photo by Palmer.*

**Cartridge cases for anti-tank guns being tapered at the Frankford Arsenal, Philadelphia.**

Each milling machine should be kept in a separate room and the number of rings in the room should be kept at a minimum. A ventilating system should be provided to remove the dust, and each milling machine should have a separate ventilating system not connected to a common duct. In these ventilating systems also, it is advisable to wash the air clear of the dust by means of spray nozzles in the ductwork as close to the milling machines as practical.

Ordinary lathes are not so suitable for use in facing the timer rings because the tool will burr and heat sufficiently to flash the powder in the ring.

The holes which have to be drilled in the milled powder rings may be done in ordinary machine rooms, but again, special attention must be given to sweepings, and chips should be removed by a water-wash blower system to a water-wash collector located outside of the building. From the collector the water flows to the sewer.

In drilling, the suction openings should be within one inch of the drill and an air movement of about 75 ft. per minute over the work is desirable. In facing, an air movement of about 125 ft. per minute across the work should be provided.

The several passages in the fuse which carry the flashback to the powder magazine of the fuse are filled with compressed pellets of black powder in the form of hollow cylinders. There are four of these pellets in each fuse, of which two have a minute strand of guncotton in the center to give a rapid action of the fuse when it is set on zero. The work of inserting these pellets offers no serious hazard and is done at a long table in conjunction with certain other assembling processes. Since there is some breakage of these pellets, the tables and floors should be kept clean by constant sweeping.

These powder pellets are in some cases made in the same plant. The work consists of compressing a dry, fine grain, black powder to the desired shape, and the apparatus used consists of a funnel-shaped reservoir for powder, a measuring device, and a remote controlled, automatically operated press. Not more than ¼ lb. of powder should be used in a machine at one time. Each pellet machine should be placed in a room by itself, so that a flash in one machine will not be communicated to the other machines. A tight floor covering should be provided around the machine and it should be curbed to confine the powder and to facilitate sweeping. Flashes in the reservoirs are said to be a rare occurrence, and due to the heavy construction of the reservoirs, are not serious.

After the pellets are made they are sent to the inspecting bench and some pellets are threaded with guncotton. Even in the largest plants, the amount of guncotton need not be very much over a pound. About 2 oz. will suffice for 9000 fuses.

The small amount of powder and guncotton concerned in the preparation of the pellets constitutes a relatively small hazard, but employees should be closely supervised to prevent carelessness in this process.

The powder-filled surfaces of the top and bottom time rings are covered with onion skin paper, secured in place and covered with shellac. The upper surfaces of the body and lower time ring are covered with a waterproof felt washer having proper perforations at the flash hole. The felt is secured in place with glue and is subjected to a heavy pressure.

After the assembling processes, the magazine in the base of the fuse is filled with a coarse-grain black powder by inverting under a boiler plate powder cone and measuring out a charge of about 100 grains of powder.

In this filling process, powder is spilled, so the work table should be zinc or copper covered and provided with a marginal trough which may be filled with water. A seamless floor, free from exposed nail heads, should be provided.

The powder reservoir or cone should not contain over 1 lb. of powder and should be of ⅜-in. iron plate, vented through the roof in the full diameter of the top of the cone. The vents should be loosely covered to prevent roof fires and to prevent dust and moisture from entering the powder reservoir. Powder in the filling rooms should be brought in only as needed and the supply should be kept at the absolute practical minimum. The usual precautions as to removal of dust from floors, table, and walls should be observed, and adequate quantities of extinguishers should be provided. Because of the quantities of powder used in the final filling process, the equipment should be in separate rooms or preferably in separate buildings.

The assembly of the percussion primers into the fuse is a hand process and without a serious fire or explosion hazard. These primers should be brought in only as needed and handled very carefully. Detonation of these primers in quantities up to 1000 will cause damage only of a localized nature to the building and equipment, but may cause serious injury to employees.

(b) **Mechanical Fuses.** Anti-aircraft fuses are now usually of the mechanical type which uses a clock train for timing. The clockwork is started on firing of the projectile and detonates a primer at the conclusion of the set time. The primer in turn flashes to a small charge of powder which communicates to the powder in the central tube of a shrapnel shell or to the detonator of the booster charge in a high explosive shell. It is understood that high explosive shells are now generally being used for anti-aircraft work.

The clockwork mechanism of the mechanical fuse is generally manufactured in clock, watch, or instrument factories, and the only hazard of the assembly is in the loading of the fuse. The hazard of insertion of the primer is the same as with the shrapnel fuse, but the amount of powder used is small and it is received in packages containing one pound of powder in small silk bags, each holding 20 grains of black powder. The size of these small silk bags is about that of the ordinary 25-cent piece.

The hazard presented by the percussion primers is the same as with the powder train type of time fuse. Because fine, loose powder is not handled, there is less hazard in loading the fuse, but precautions in handling and storage of primers and powder should be taken as recommended for the powder train type of fuse.

(c) **Base Fuses** (impact detonation). The base fuses used with armor piercing shells and high explosive shells are apparently loaded only in arsenals. At least there is no information as to any of these fuses being manufactured and loaded in industrial plants not commonly making a practice of carrying out such work. Although these base fuses do not use black powder, they may contain a considerable quantity of detonating material and a small booster charge.

### V. Fuse Detonators or Percussion Primers.

The manufacture of the percussion primers or detonators for shell fuses is a considerably more hazardous operation than any so far described. Since these operations will not be generally encountered in the average industrial plant, no description of the operations involved will be given.

The detonators may be shipped in carefully packed containers holding 10,000 units. The explosion of this quantity of detonators can cause severe localized damage to the building and equipment and probable fatal injuries to employees in the near vicinity. Not over 1000 of these detonators should be in any one assembly area, the remainder being stored in an insulated box in a safe location separated from the powder magazine.

### VI. Storage of Powder and Detonators.

Powder and detonators should be separately stored in accordance with the recommendations of the Suggested Explosives Ordinance accepted by the N.F.P.A. at the 1941 meeting in Toronto, Ontario, except where these recommendations conflict with local or state regulations. Magazines should be located in accordance with the quantity and distance table incorporated in Chapter 7 of the Suggested Explosives Ordinance.*

When small quantities of detonators and powder are kept on hand, they may be stored in Class B magazines as described in the Ordinance.

### VII. Marking of Projectiles.

All projectiles are painted as a means of rust prevention and for ready identification.

A shrapnel projectile is painted red, denoting that it contains a "low explosive." There is also painted on the projectile the caliber and type of gun in which the shrapnel projectile is to be used.

High explosive shells are painted yellow, and chemical projectiles are painted blue-gray.

High explosives and chemical shells are marked to indicate the contents of the projectile, and on chemical shells below this are painted color bands to denote the characteristics of the chemical with which the projectile is filled. One yellow band denotes smoke chemical, a green band or bands denotes gas.

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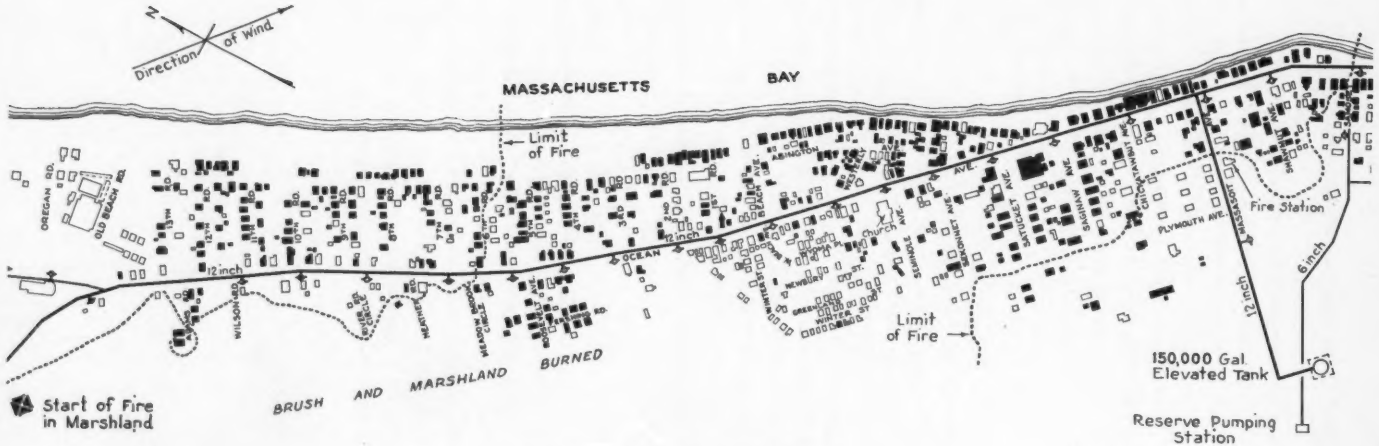
*Advance Reports, Part 2 of the April, 1941, QUARTERLY, pp. 32-35.




**OCEAN BLUFF CONFLAGRATION**

MARSHFIELD, MASS.

APRIL 21, 1941.

Scale in Feet

0 200 500

Buildings with wooden shingle Roofs shown in Solid Black

# Marshfield, Mass., Conflagration.

By P. C. Charnock,
New England Fire Insurance Rating Association.

At 1:50 P.M. on April 21, 1941, an alarm was sounded for a small grass fire in Marshfield, Mass. When the fire which had this modest beginning was finally extinguished at 6:15 P.M., some 450 buildings in the congested area of Ocean Bluff, which lies along both sides of Ocean Avenue between 8th Road on the north and Samoset Avenue on the south, were in ruins. A property loss of approximately $1,000,000 was sustained.

Fanned by a northwest wind at 30 miles per hour, the grass fire spread rapidly through waist high marsh grass and then raced across a wide area faster than hose lines could be laid, to ignite several isolated frame structures along the west side of Ocean Avenue about opposite 12th Road. Embers from these burning buildings quickly set fire to the thickly built area south of 6th Road through the medium of shingle roofs, and the main body of the fire was soon beyond control. Buildings having non-combustible roofs were quickly involved through heat radiation.

The arrival of the local call department was reasonably prompt, three auto pumpers and one combination responding on the first call, an additional pumper answering the second call, with a total of some 40 call men. It was apparent that the local department would be unable to cope with the situation and twenty minutes after the first alarm, outside aid was called. The response of this aid was said to be prompt. It came from Bourne, Cohasset, Duxbury, Falmouth, Hanover, Hull, Pembroke, Plymouth, Rockland and Scituate; 26 pieces were sent, which included 11 pumpers, 4 hose wagons, 4 ladder trucks, 5 forest fire trucks, 1 rescue truck and one 1800-gallon tank wagon, with 175 paid and volunteer firemen.

The area burned was approximately 6000 feet long and 1000 feet wide. The property destroyed consisted mainly of summer dwellings, with one church, two hotels and several mercantiles. Construction was entirely frame except for one stone church.

As shown on the accompanying map a considerable proportion of the buildings involved had wood shingle roofs. Very few of the buildings were suitable for year-round occupancy; it is estimated that approximately 40 were so used. Buildings were very closely spaced on small lots in most cases, and the congestion was largely responsible for the rapid spread of the fire.

*Wide World.*

**Ruins of the Ocean Bluff section of Marshfield, Mass., following the conflagration which occurred there on the afternoon of April 21. Flames starting in the marshlands, top right, swept into the built-up area fronting the Atlantic Ocean. Burned buildings were almost entirely frame summer homes and hotels.**

Weather conditions on April 21 were unusually favorable for a fire. Very little rain had fallen for several weeks and a low humidity had prevailed for a considerable period. A 25 to 30 mile an hour wind was blowing from the northwest. It was this wind which fanned the small blaze into a conflagration and which carried flaming brands across the congested beach district, starting fires all over the area on the thoroughly dry and tinder-like wooden shingle roofs.

The water supply in this area consisted of a 12-inch main of the Marshfield public water system along Ocean Avenue, with hydrants spaced every 300 feet approximately. There were no hydrants in the areas east and west of Ocean Avenue and long lines were necessary in some cases to reach the outer limits of the fire.

Adequate fire flow for group fires is available at pressures suitable for engine supply, but these quantities would not be sufficient to control fires which involve extensive areas. For a short time during the height of the fire, departments were handicapped by low pressures when intense heat and flames forced fire fighters to abandon at least three hydrants and leave hose lines connected to them still flowing.

*International.*

**A row of cottages feed the flames at Marshfield. These were only three of 450 such homes which were destroyed on the afternoon of April 21. Towns as much as 50 miles away sent equipment to aid in fighting this fire, one of the worst which has hit New England in several years.**

Elevated storage on the Marshfield system includes one 150,000-gallon elevated tank located just off Ocean Avenue at Massasoit Avenue adjacent to the area involved in this fire; one 660,000-gallon standpipe at Marshfield Center, and one 264,000-gallon standpipe at Marshfield Hills. The elevated tank was reported to be full at the start of the fire and standpipes were said to be approximately 3 feet below full water level. Storage in the elevated tank at Massasoit Avenue was practically depleted at 6 P.M., when the fire was finally extinguished. Four pumping stations with a combined delivery of 1,300,000 gallons per day were reported to be operating during the fire. Normal daily consumption at this season of the year is approximately 300,000 gallons; consumption on day of fire is estimated at 1,250,000 gallons.

Very few services in the burned area had been turned on when the fire occurred and the loss from broken services was negligible. Poles carrying telephone cable and light and power lines were destroyed throughout the entire area, and both utilities were out of service until 6 P.M. the following day. Few gas services had been connected and no particular difficulty was encountered from this source.

*International.*

# The Plymouth Rubber Co. Fire.

A large building of another plant working on defense orders, the Plymouth Rubber Co. of Canton, Mass., was reduced to charred ruins on April 2, 1941, as the result of the neglect of a number of fire protection principles. In addition to the interruption of defense production and throwing more than 500 men out of work for several weeks, a loss of $500,000 was incurred.

The fire started late in the afternoon on the third floor of one of the plant buildings which was used for curing. The building was of brick and timber construction and was 190 by 80 ft. Used in the process was a mixture of gasoline and carbon tetrachloride in the proportion of 66 per cent gasoline to 34 per cent $CCl_4$.

Friction sparks developed and fire flashed into the curing machine. Sprinklers within the machine operated promptly, it is stated, but apparently at some time during the early stages of the fire they were shut off. This may have been done by employees who commenced to fight the fire with soda-acid, carbon dioxide, and carbon tetrachloride extinguishers.

Employees fought the fire in this way for 20 minutes before the fire department was called, and then, a telephone call was made requesting gas masks only. The fumes from the carbon tetrachloride had become so severe that the masks were deemed necessary.

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This account of the Plymouth Rubber Co. fire is based upon a report by the Eastern Underwriters Inspection Bureau, and data from other sources.

A deputy chief responded to the call, and when he entered the third floor where the fire had originated, he was immediately set back by smoke and fumes. He called department apparatus immediately, but by the time it had arrived, the fire was beyond control.

The fire protection principles which were neglected in the case of the Plymouth Rubber Co., and which led to the large loss, began with the curing process where a flammable liquid was used. To render gasoline non-flammable by the addition of carbon tetrachloride, much more carbon tetrachloride is needed.

Secondly, the fire department should have been called immediately before the fire was fought with first aid appliances. Emphasis has always been laid on the fact that a call for the fire department should be made first, followed by first aid.

Third, the sprinklers were shut off. Following the fire no one could be found who would admit taking this action.

Fourth, the fire department should have responded with apparatus after the first call had been received from the Plymouth Rubber Company. Time was lost while the deputy chief went to the plant with gas masks.

From 1914 to the present time, at least 23 fires have been reported in this plant.

# St. John, N. B., Group Fire.

By C. F. Clarkson, Inspector,
New Brunswick Board of Underwriters.

One man was killed, two others were severely injured, and a $425,000 loss was sustained when fire swept through the Emerson and Fisher Building in St. John, N. B., early on the morning of March 27, 1941. Four other near-by buildings also suffered damage in varying degrees, two three-story frame structures nearly a mile away were fired by flying embers, and a ladder truck was all but destroyed. Had it not been for an adequate water supply and the untiring efforts of fire fighting and military units and civilians, the entire area might have been destroyed.

The Emerson and Fisher Building was a six-story brick-joisted structure given over to wholesale and retail hardware merchants. The interior was of light wooden construction with unprotected floor openings. Protection consisted of a dry-pipe automatic sprinkler system with dual water supply. This system failed to operate and give an alarm when the fire occurred because the dry-pipe valve (installed in 1924) failed to trip. After the fire, the valve was found tripped, presumably having operated at about the time the building collapsed, too late to be of any value.

**The Emerson and Fisher Building, looking west, following the fire. One man was killed and two others were severely injured in the building on the left (South) when its roof and floors collapsed. The collapse resulted when the wall of the Emerson and Fisher Building fell outward.**

The fire started prior to 1:30 A.M., for an occupant of a near-by building detected smoke at that time. A half an hour later, an alarm still had not been given, but dense clouds of smoke awakened another resident of the same near-by building. Finally, at 2:07 A.M., the fire department was called.

The members of the department first tried to enter the burning building and fight the fire from the inside. It immediately became evident, however, that the fire had already made too much progress for such action. From that time on, all fire fighting was done on the exterior.

The fire department did not connect to the sprinkler system. They made an attempt, but heat and flame prevented, according to their statement. Some witnesses expressed the opinion that the connection might have been made when the fire department first arrived. However, owing to the delayed alarms, it may at that time already have been too late for effective sprinkler operation.

After 2 A.M., the fire spread rapidly and it was not long before the building was completely involved. About 3 A.M., the roof and floors began to fall and at 3:30, the front wall and upper three floors of a section of the left wall fell outward. The fire was not entirely extinguished for several days.

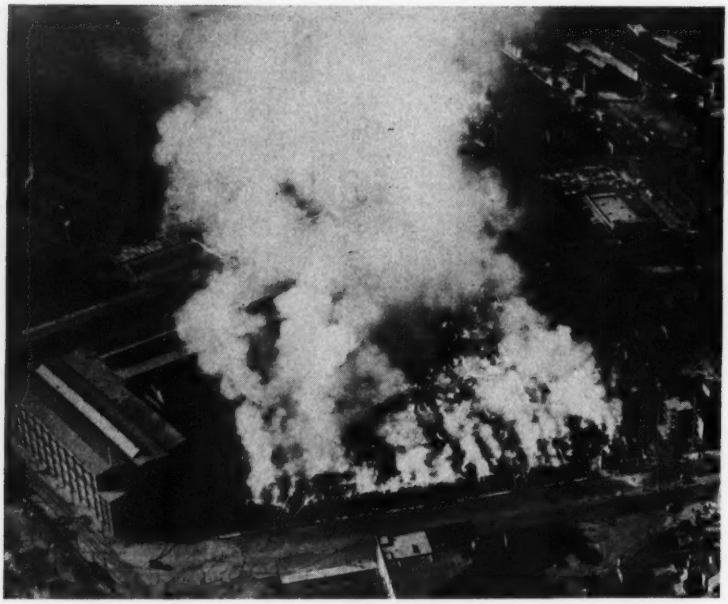
When the south wall of the Emerson and Fisher Building fell, it caused the collapse of the roof and floors of a three-story building on the southern

**Shortly after this picture was taken, the front wall of the Emerson and Fisher Building in St. John, N. B., collapsed, burying the ladder truck shown. To save the truck was impossible. Heat buckled the ladder so that it could not be lowered, and wires crossing the street prevented driving the truck away with the ladder raised.**

exposure. Three men were pinned under the débris and one of them was killed. The fire did not enter this brick-joisted building.

On the northern exposure, another three-story building became slightly involved when fire entered through the front windows. Across the street, a two-story garage was set afire several times and there was some damage. The building next to the garage was similarly damaged and other buildings in the vicinity were damaged slightly. Flying embers from the Emerson and Fisher Building were showered over a large area by a moderate wind, but a light rainfall and soldiers and civilians were instrumental in checking most of the fires. One serious fire occurred in two three-story frame buildings nearly three-quarters of a mile away.

Had the sprinkler system been in operation it is probable that the fire would not have spread rapidly and an alarm would have been sounded much sooner. This tremendous loss shows the absolute necessity for making complete tests of sprinkler systems regularly. Although the alarm was tested each week, the dry pipe valve of the system had not been checked since 1938. If a pumper connection had been made to the system, it might have aided in reducing the loss.



# Philadelphia Lumber Yard Fire.

The William H. Lear Lumber Yard, occupying a triangular shaped city block of more than four and a half acres in Philadelphia, caught fire on the night of May 15, 1941, and was destroyed with a loss of $900,000. The yard was heavily stocked at the time and lumber was piled to a height of 30 feet in places. The death of two persons can be attributed to this blaze, which demonstrates the danger of permitting such large masses of combustible materials to be stored in close quarters. Such fires cannot be controlled by even the most competent of fire departments regardless of the amount of water they are able to hurl against the flames.

Fifty-nine per cent of the lumber was stored in buildings of either frame or corrugated iron on wood construction. All space which was not occupied by these buildings was also filled to capacity with lumber. The entire area was enclosed on the street fronts either by buildings or by fences, the latter approximately eight feet in height.

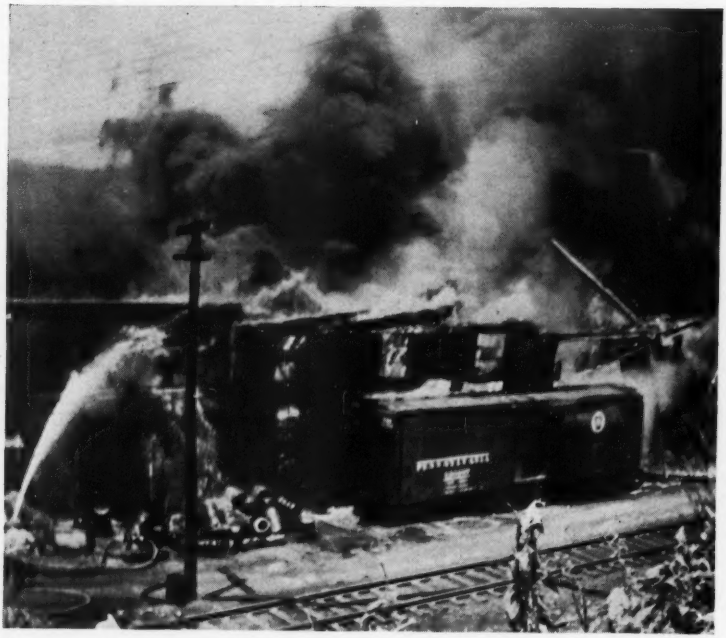
Smoke was noticed about 1:35 A.M. by a woman residing across the street from the yard. She called her husband, who in turn called the fire department. By the time the alarm was sounded at 1:44 A.M., the entire yard was involved and when the department arrived there was little that could be done except to protect the buildings surrounding the yard on all street fronts. At 8:30 A.M., almost seven hours after the first alarm, the fire was finally brought under control, although there was fire in the ruins for several days before extinguishment was completed.

Due to the fact that much of the lumber stored in the yard was being used in the construction of planes and other defense goods, sabotage was at first suspected. This theory was eliminated, however, when a kerosene lantern was found beside the remains of the watchman in one of the buildings. It was thought likely that the watchman, who was 72 years of age, suffered a coronary or cerebral thrombosis, possibly as early as 11:30 P.M. or midnight. This, it is believed, caused him to fall and set the building afire. The fire inside the building then had more than an hour's time to spread before it could be seen by someone on the outside.

In addition to the complete loss of the lumber yard and two lives (the second of which was indirectly caused by the fire), the fire department lost a considerable amount of material, and approximately 60 men required first aid or hospital treatment. Many of the buildings on the opposite sides of various streets which bounded the yard were also damaged to a considerable extent. These buildings included a one-story brick storage, stable and automobile house owned and occupied by William H. Lear, proprietor of the lumber yard, and the adjoining three-story, brick, sprinklered woodworking plant of Erik Jansson, Inc.

On another street, two large brick buildings being fitted for occupancy by a shipbuilding concern were also materially damaged. A one-story brick and frame building, housing the Quaker City Boiler Works, and the one-story frame building and shed of an automobile freight storage and loading platform were also fire damaged. Some bricks dwellings were so severely hit by the flames that demolition was necessary.

This fire in the Lear Lumber Yard demonstrates that large areas of highly combustible material can never be considered safe. This blaze might never have started, however, had the lumber yard furnished their watchman with an electric rather than a kerosene lantern.



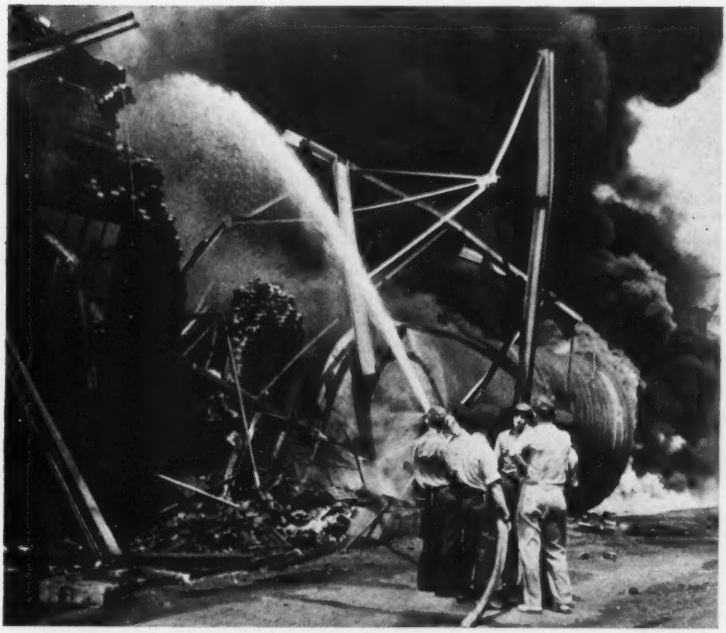
*Acme.*

# Wheeling Machine Products Company Fire.

A $300,000 fire in the Wheeling (W. Va.) Machine Products Company which was initially believed to have been sabotage, turned out to be the result of a disregard for elemental fire protection measures. The fire occurred on the afternoon of June 8, 1941, in this plant which was engaged in filling defense contracts.

The plant was a one-, two-, and three-story structure of mixed construction, much of which was combustible. It was approximately 400 feet in length and 100 feet wide and was separated into seven sections by walls with unprotected openings. Stairway openings were also unprotected. The plant did not have automatic sprinkler protection and the only hydrant available was within 20 feet of the building. The plant site bordered on the Ohio River, but no approach had been prepared for pumpers to make use of this water supply in the event of a fire.

Generally, the plant had been in operation 24 hours a day. On the afternoon of June 8, however, operations had ceased for a general clean-up. On duty were a watchman and several maintenance men.



**One of the two 5000-gal. oil tanks adjacent to the plant. At the height of the fire, this tank, which was supported by unprotected steel framework, collapsed, fell into the burning building and was punctured. Oil helped to feed the flames.**

Shortly after 1:00 P.M., the watchman discovered fire in a basement sorting room in the south end of the building. A visit to the same room 20 minutes earlier had revealed no flames, according to the same man. The fire spread rapidly in both horizontal and vertical directions and when the department arrived ten minutes later, the flames were already out of control. Aiding the spread of the fire was oil soaked flooring under many of the machines used in the plant. In addition, one of two 5000 gallon light oil tanks immediately adjacent to the building collapsed during the course of the fire, fell into the burning building and was punctured. This oil helped to feed the flames.

Firemen laid four lines from the only available hydrant, but since it was within 20 feet of the hottest part of the fire, one of the four lines had to be used almost constantly to prevent the other three lines from burning. To lay another line from a hydrant nearly a mile away, two pumpers in tandem were necessary. The flames were finally checked when they reached a section of the building constructed of steel, although it was necessary to pour water on the ruins for over 20 hours.

The fact that a plant so vitally important to our National Defense should be gutted by fire is more than merely "deplorable." The circumstances sur-

rounding this fire give no indication that fire protection had been given consideration by the plant's management. In view of the loss of $300,000 which was sustained and the indirect losses which in times like these are far more important, fire protection would have been common sense.

**A view of the Wheeling Machine Products Company which was destroyed on June 8 by fire. Only one hydrant was available for fire fighting operations, although a 30-inch main ran past the plant. The inexhaustible supply of water in the Ohio River near by could not be used since no approach had ever been made for pumpers.**

# Jersey City Waterfront Fire.

By Wm. G. Hayne,
New York Board of Fire Underwriters.

Saturday, May 31, 1941, fire starting in cattle pens of the Jersey City Stock Yards Company at the foot of Sixth Street, Jersey City, New Jersey, spread northward to the Erie Grain Elevator across a 150 ft. slip. It involved the entire elevator and pier structure and finally spread across a 210 ft. slip to seriously damage a large six-story concrete, sprinklered, warehouse building. A one-story frame warehouse building and numerous freight cars and barges were also damaged.

The fire started at about 6 P.M., and was not under control until the following morning. It resulted in practically complete destruction of 135 cattle pens and the wharf structure upon which they were constructed, an entire grain elevator, a transfer elevator, a feed mill and the pier structure upon which they were built. Also destroyed was a loading dock of the Erie Railroad at the foot and south side of Pavonia Avenue. The east section of the fire-resistive warehouse and the merchandise stored there sustained considerable damage.

In general, the fire demonstrates the hazard of large frame structures located along the waterfront where they are accessible to land companies from one narrow end only. It also demonstrates the exposure hazard such structures present to other property even across such comparatively wide distances as a 210 ft. slip. Further, it demonstrates that automatic sprinklers cannot be expected to cope effectively with a severe and prolonged exposure fire. It also indicates that buildings of reinforced concrete construction using concrete formed of materials as used in the construction of the Midhudson Warehouse, may sustain damage quite disproportionate to the severity of the fire. Finally, it demonstrates the possibility of waterfront fires of conflagration proportions when there occurs the combination of flammable pier or wharf structures and slips blocked by numerous combustible barges that not only communicate the fire from one pier structure to another, but also prevent efficient operation of fireboats. In addition, it indicates the vulnerability of waterfront structures to possible air raid attacks.

## Description of Buildings.

The Jersey City Stock Yards Company cattle pens involved in this fire consisted of 135 pens built upon a pier structure of three-inch plank showing evidence of considerable rot, on heavy wood girders on wood piling. The pier was 110 ft. wide and 1295 ft. in length, covering an area of 142,450 sq. ft. The cattle pens were of the usual type of construction, consisting of wooden fence work erected to a height of about four feet above the floor and provided with

Looking southwest into the heart of the fire.

Acme.

feed bins built along several sides, usually containing quantities of hay. Except for a runway on the north side, the pens were covered by a ventilated corrugated iron roof supported on unprotected steel trusses and columns. At the land end of the pier there were two small cement block buildings containing lockers and a carpenter shop, and farther east was a high one-story reinforced concrete building with eight-inch hollow tile curtain walls covering an area of 6000 sq. ft., used for the storage of hay. An office building, also additional cattle sheds west of the above buildings, covering an area of 118,750 sq. ft., were not involved in this fire.

The Erie Grain Elevator, erected in 1880, was 155 ft. in height. It was 81 ft. wide and 360 ft. long, covering an area of 29,160 sq. ft., with a capacity of 1,500,000 bushels. The first floor walls were brick supported on steel I beams resting on large granite piers built up from the river bed. Above the first floor the elevator was constructed of 2-in. planks covered with sheet metal on the outside, on a framework of heavy timber and unprotected steel trusses. Bins were of wood cribbed construction. A brick boiler house was located west of the elevator. East of the elevator was a five-story transfer elevator and boiler house. All structures rested upon a wood pier structure on wood piling. The pier containing all of these structures is approximately 1000 ft. in length.

The Erie Railroad storehouse and loading pier at the foot of Pavonia Avenue was of frame construction on wood piling. The building was one story in height and was located at the river end of the pier. The south side of this structure faced the water, while on the north there was a frame train shed and a railroad siding.

The Midhudson Warehouse at 29-51 Pavonia Avenue is a six-story structure of reinforced gravel concrete construction covering an area of 32,880 sq. ft. Walls consist of 14 x 28 in. reinforced concrete pilasters and girders with twelve-inch brick supported on the concrete girders under windows. Floors are five-inch reinforced concrete supported by reinforced concrete beams, girders, and columns. Floors are provided with scuppers. Roof is four-inch reinforced concrete supported the same as floors. Stairs are enclosed in six-inch reinforced concrete and elevators in six-inch hollow tile, all with good doors. The building is divided into an east and west section by a six-inch reinforced concrete division wall, with one opening on each floor protected by class A Underwriters Laboratories' labeled fire doors on the east side of wall only. Windows were wired glass in metal frames and constituted a large portion of the wall area.

### Protection.

The stock yards and grain elevator were provided with standpipes and first aid appliances. The Midhudson Warehouse was equipped with a good automatic dry pipe sprinkler system supplied by two 30,000-gal. gravity tanks

elevated 22 ft. above highest sprinkler and three 7500-gal. pressure tanks. There were approximately 210 sprinkler heads on each floor in each of the two sections, supplied through six-inch risers. Siamese connections for Fire Department use are located at each corner of the building. The warehouse was also equipped with four six-inch standpipes, one in each stairway in each corner of the building, provided with lengths of two and one-half-inch hose and nozzles. Siamese connections similar to the sprinkler system were provided for the standpipe system.

### Weather Data.

Records of the United States Weather Bureau at the Battery in New York, a short distance from the fire, show an average temperature of 65° F. the day of the fire. The wind during the period of the fire varied from 4 to 18 miles per hour. It was south at the start of the fire, later shifting to southwest, then south, southeast, east and north.

### Occupancy.

Records indicate that at the time of the fire the pens of the Jersey City Stock Yards Co. contained 554 steers, 20 bulls, 2 cows, 960 lambs, and 300 calves.

The Long Dock Co. states that the Erie Grain Elevator contained, at the time of the fire, a total of 291,000 bushels of wheat, corn, oats, barley, and soy beans. The east section of the Midhudson Warehouse contained merchandise as follows:

1st—Steel, baled rags, crushed bone, rubber, small boats.
2nd—Print paper, cocoa beans, chicle, gum, tapioca, flour, soap powder, composition tile.
3rd—Raw coffee beans, print paper, paper cartons, liquor, electric toasters, leather.
4th—Vacant.
5th—Large quantity of crushed bone in bags.
6th—Coffee in cans in paper cartons, leather, print paper in rolls, crude rubber, electric toasters in paper cartons.

A large quantity of new automobile tires were on the loading platform of the Erie Railroad on the south side of Pavonia Avenue.

### Story of the Fire.

The records of the American District Telegraph Co. indicate that the first alarm was received from the office building of the Jersey City Stock Yards Co. from their box No. 351, at 6:02 P.M. Saturday evening, and was immediately transmitted to the Fire Department. The cause of the fire has not been determined. There appears to have been some delay in sounding the alarm, the city authorities being of the opinion the delay was as much as 20 minutes. The Fire Department responded to this call with three engine companies, two truck companies, one salvage company, and one special company. Upon the arrival of the Fire Department the greater portion of the structure containing the pens of the Jersey City Stock Yards Co. was involved and the fire was rapidly spreading to the Erie Grain Elevator. A second alarm was transmitted at 6:10 P.M., followed by a third at 6:15 P.M. and special calls at 6:16 P.M.

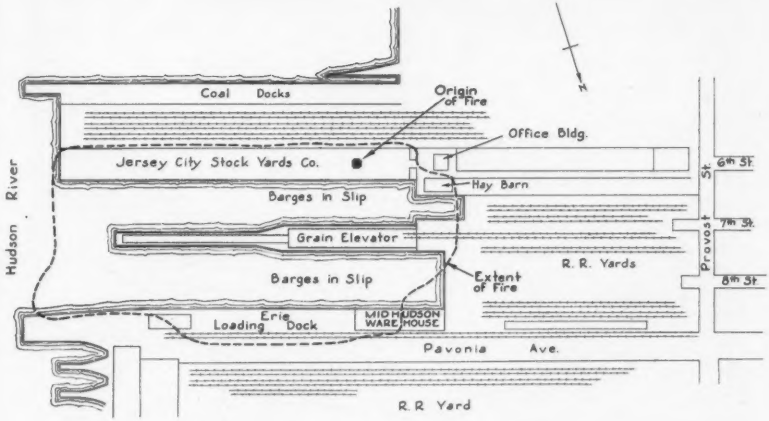
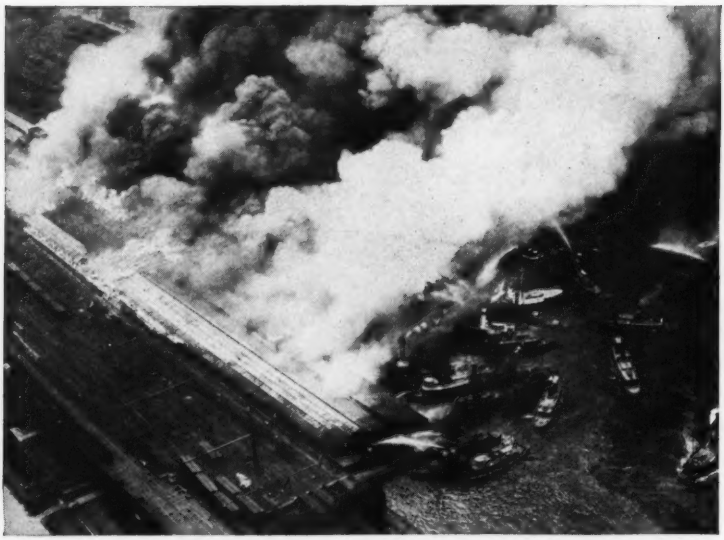



**Diagram of the Fire Area. (Not to Scale.)**

The apparatus brought to the fire by these alarms totaled 12 pumpers, 4 trucks, 4 salvage trucks, 1 water tower, 1 high pressure truck, 1 light company, and 1 special company, also uniformed personnel consisting of 1 chief, 3 deputy chiefs, 6 battalion chiefs, 38 captains, and 285 firemen. In addition, two fireboats from New York responded, the *Fire Fighter* at 6:40 P. M. and the *John J. Harvey* at 7:50 P.M. The fire quickly spread to the grain elevator across the 150 ft. slip between the stock yards and the elevator. It appears that its spread to the elevator was aided by cattle boats and barges in this slip. Mooring lines of the cattle boats and barges apparently burned away and permitted the burning boats to drift over to the grain elevator side of the slip. The fire department took positions west of the cattle pens and along the bulkhead line, and as the fire spread to the Erie Railroad Storehouse and dock along Pavonia Avenue and the Midhudson Warehouse, positions were taken along Pavonia Avenue. Water was supplied to the standpipe and sprinkler systems of the Midhudson Warehouse through the siamese connections of these systems. Long stretches of hose (20 lengths) were required to reach the greater portion of the stock yards and in addition these lines were hampered by freight cars south of the stock yards. Engine companies along Pavonia Avenue were supplied with water from a twelve-inch city main. In addition the fireboats supplied heavy calibre streams to the water tower, high pressure company, four salvage turrets and deluge set, using 70 lengths of three and one-half-inch hose. Except for the twelve-inch main on Pavonia Avenue and an eight-inch main in the stock yards at the foot of Sixth Street, there was no fresh water supply readily available and suction from the river was necessary. The fireboats were unable to enter the slip between the stock yards and the



*International.*

**Fireboats and tugs could not get into the slips between piers in the early stage of the fire when it was spreading beyond control.**

grain elevator in the early stages of the fire because of the intensity of the fire and because of burning barges in the slip. The fireboat *Harvey* was hampered by tugs which retarded her entrance into the slip between the grain elevator and the Midhudson Warehouse, and was only successful in entering this slip after receiving the coöperation of the United States Coast Guard. Both fireboats were considerably hampered by burned and submerged barges in both slips and could not get into the slips until the barges had been removed by railroad tugs. Numerous railroad tugs assisted in fighting the fire, especially in protecting the ferry slips at the foot of Pavonia Avenue.

The construction of the stock yards and the grain elevator were such that the fire spread through them rapidly and as they were accessible to the land companies from one narrow shore end only, the fire department was unable to cope with them successfully and consequently the fire became of conflagration proportions. The southwest wind carried the smoke and heat of the fire to the southeast corner of the Midhudson Warehouse and at approximately 9:00 P.M., in spite of the efforts of the fire department and the operation of the automatic sprinkler system, merchandise in this section of the warehouse ignited. The operations of the department, therefore, were then concentrated upon this building, although it is claimed by the department that hand lines were in this building previous to this time. The fire was considered under control the following morning.

## Damage.

Except for a small section at the river end, practically all of the structures extending eastward from the bulkhead line and occupied by the Jersey City Stock Yards Co. were destroyed, and at many points the wood piling was burned to the river level. Three hundred ninety-one steers, 960 lambs, and 300 calves were reported lost. The locker room building and carpenter shop at the land end of the pier were partially damaged. The hay storage building was slightly damaged and many bales of hay were destroyed. The Erie Grain Elevator and its contents, also the pier upon which it was constructed, as well as the other buildings upon the pier appear to be a total loss. The Erie Railroad loading dock, railroad siding and shed on the south side of Pavonia Avenue, including a number of freight cars, their contents and the merchandise upon the loading platform, sustained severe damage. Structural damage to the Midhudson Warehouse is confined to the east section of the building. Seven interior columns on the fifth floor at the east end of the building collapsed, permitting a portion of the sixth floor and the roof to drop, breaking the wall pilasters along the east and south walls. Many interior columns, girders, and beams are badly spalled, exposing the reinforcing steel. In several instances the concrete of beams and girders is entirely missing. Merchandise on the third, fifth, and sixth floors of the east section of this warehouse was badly damaged by the fire. Merchandise on other floors of this section and in the west also was damaged by smoke and water. Water damage to foodstuffs was increased due to the use of river water for hose streams. Barges, tugs, and railroad cars also were damaged, several barges having sunk.

The insurable value involved is estimated at $10,000,000, with loss estimated at $5,000,000.

## Conclusions.

Above anything else, the fire serves to emphasize again what may be expected to occur in structures of this character along the waterfront.

It should not be expected that fire departments will be able to cope successfully with fires in structures constructed and located as were these stock pens and the grain elevator. Stock pens consisting of light wooden fencing with quantities of hay strewn about have frequently proven to be conflagration breeders. Likewise piers with wood decks and wood cross members and piling have often been the source of severe fires. The grain elevator constructed almost entirely of combustible material and located with other buildings upon a long pier, the greater part of which was also of combustible construction, was accessible to the land companies of the fire department only at the narrow shore end. Barges and tinder-like cattle boats in the slip between the cattle pens and the grain elevator not only assisted the fire in bridging the gap between these two structures, but also prevented the fireboats from entering the slip. The elevator, therefore, could not be protected against the exposure fire in the cattle

*Acme.*

**The New York fireboat "Fire Fighter" pouring 8000 gallons of water per minute through a 5-in. nozzle, into the still smoldering contents of the Midhudson Warehouse. River water was not good for foodstuffs, electric toasters, etc., but it was necessary to put out the fire. This building was sprinklered, and had wired glass windows, but the exposure was too severe, and the contents so closely piled that the firemen could not do any effective work inside.**

pens and the barges, nor once becoming ignited could fire in it be successfully fought from the narrow shore end. After repeated large pier and wharf fires the Committee on Piers and Wharves of the National Fire Protection Association surveyed the pier and wharf conditions in all of the major ports in the United States with respect to the present construction of the piers and wharves in these ports and existing legislation governing such construction. This survey revealed that the major number of piers were of combustible construction and that few ports have any laws governing the construction of piers and wharves with respect to fire prevention. The Committee, therefore, prepared a model ordinance for piers and wharves and it is believed that the adoption of such an ordinance should be considered by the Jersey City authorities as well as other port authorities throughout the United States.

The serious damage to the structure of the Midhudson Warehouse appears to be largely due to the materials used in the composition of the concrete used in its construction, especially the coarse aggregate. This aggregate was gravel, apparently of a type common to this section of the country. Previous fires involving reinforced concrete buildings using such gravel as the coarse aggregate.

have shown that the damage is entirely out of proportion to the severity of the fire. In this instance there is nothing to indicate that extremely high temperatures were reached, except at one or two points, on any floors of the building, although the fire was of long duration. Seven interior columns on the fifth floor, however, appear to have practically disintegrated, and in addition many beams and girders failed, some of which supported only the roof load. Reinforcing steel is exposed on many other columns, beams, and girders. The inability of buildings constructed of reinforced concrete using quartz gravel as the coarse aggregate to withstand exposure to fire was recognized and investigated years ago and was attributed to the gravel aggregate.

The inability of the sprinkler equipment to extinguish the fire in the Midhudson Warehouse should not be considered as a failure of this equipment. The system appears to have functioned as intended; however, the long continued exposure fire seems not only to have continually reignited the contents of the warehouse, but also to have caused such a large number of heads to operate, estimated at over 600, that the system was soon drained and fire department connections to the siamese were not nearly sufficient to supply all of the heads that opened. It should be realized, therefore, that unless a sprinkler system is provided with an ample and continuous supply of water from a source other than the tank supply, it cannot be relied upon to protect a building against a severe and prolonged exposure fire.

The large window area with which the Midhudson Warehouse was provided undoubtedly was a factor in the passage of heat from the fire in the grain elevator into the warehouse. Smaller window area would not only have lessened the amount of the heat transfer, but would also have reduced the area the fire department was required to cool. Open sprinklers above the windows, so arranged that they would form a water curtain, would have been very valuable equipment.

Merchandise was so piled on the upper floors of the Midhudson Warehouse that it was impossible for the fire department to reach the south wall of these floors. There appears to have been but one center aisle running east and west, and short aisles to the stairs at the ends of this aisle. Merchandise was piled along the south wall without aisle space. In warehouses it is imperative that proper aisle space be provided not only so that the fire department can operate effectively, but also that salvage operations may be conducted. The quantity of merchandise in one pile, especially material in bags, should also be limited in size. Fires involving materials in burlap bags frequently have a tendency to burrow in among the bags and spread throughout the entire pile, and are consequently difficult to extinguish. In this instance it was necessary to continually wet down the bagged storage of the crushed bone for many days.

The division wall between the east and west sections of the warehouse was provided with one opening, each floor protected by a fire door that suc-

cessfully prevented the fire communicating to the west section through this opening. The sills at these openings were not raised, however, and considerable water passed through the openings, causing water damage in the west section of the warehouse. Much of this damage would have been avoided if proper raised sills had been provided. In addition, none of the merchandise was skidded, resulting in water damage to those materials resting directly upon the floors.

It should be of interest to know that the report on Jersey City, New Jersey, prepared by the National Board of Fire Underwriters in 1919, with supplement of 1925, in the general summary under the heading of Conflagration Hazard reads, "Severe individual and extensive group fires probable in the waterfront properties."

Delay in transmitting an alarm to the fire department often results in presenting the fire department with a second, third, or even greater alarm fire upon their arrival. Employees should be definitely instructed to immediately transmit an alarm to the fire department regardless of the extent of the fire and the possibility of extinguishing it with their own equipment.

* * * * *

### Hoboken Pier Fire.

Another fire of large proportions along the Hudson River waterfront in New Jersey occurred on Pier No. 4 in Hoboken on Tuesday afternoon, April 29. This U. S. government pier was subjected to considerable damage, particularly its substructure. In addition to large contingents of the Hoboken Fire Department, three fireboats from the New York City Department fought the blaze for 32 continuous hours.

Here again, the substructure of the wharf was constructed of wooden piles and timber over which there was wooden planking. On top of that was a layer of reinforced concrete six to eight inches thick. There was no sprinkler protection of the substructure, which was accessible through a single manhole only. To provide openings to the substructure, it was necessary to break through the cement with pneumatic drills.

Three ships tied to the pier were not only endangered, but also were in the way of fire fighting operations. These ships were towed away before the fire had progressed very far. Likewise, 4000 tons of kraft paper which were stored in the pier were removed successfully.

There were several injuries sustained by firemen during the course of the fire, but none was fatal. The fire was not extinguished until Wednesday afternoon, April 30.

*International.*

# Jacksonville Pier Fire.

Fire of unknown origin completely destroyed two piers, including bulkheads and contents, in Jacksonville, Florida, on June 8. The structure loss is estimated at $600,000; the contents loss is not reported.

As is often the case in pier and wharf fires, the flames were not discovered in the wooden substructure, where they had started and made considerable headway, until smoke began to escape from cracks in the deck planking. An employee first noticed this smoke at 9:05 in the morning, and after sending an alarm for the fire department, employees tried to fight the fire with hose lines.

The fire department arrived at the scene at 9:10 and drove their trucks on to the pier in which the fire had first been discovered. The flames had made such progress, however, that they were forced to retire immediately.

For a time, the fire threatened the *S. S. Seminole* of the Clyde-Mallory Lines which had arrived in Jacksonville the same morning. The boat was finally towed from the slip with comparatively little damage. At 11:00 A.M. the fire was finally brought under control.

As in the case of many other pier and wharf fires, once fire was well under way in the inaccessible, combustible substructure, lacking automatic sprinkler protection, subdivision by fire walls, access openings for fire fighting, or any other form of protection, a heavy loss was to be expected. No fire department, however efficient, can be expected to control a fire under such conditions.

*International News Soundphoto.*

# San Pedro Wharf Fire.

A fire which completely involved the underside of a wharf and which spread to an abandoned one and one-half story frame warehouse upon the wharf on the San Pedro (Los Angeles), Calif., waterfront on the afternoon of May 14, 1941, once again demonstrates the absolute need for sprinkler protection in such properties. A rough estimation has placed the loss at $100,000.

The fire was not suspected in the wooden understructure until passers-by saw smoke curling up from the cracks in the plank decking, upon which there was no paving. The fire department received its first alarm at 1:46 P.M., and when apparatus arrived at the scene, not only the entire underside of the wharf was found to be ablaze, but also the fire had spread above and had involved 100 feet of the warehouse. The fire spread so rapidly then that 52 minutes after the first alarm, companies were being returned to their stations.

The cause of the fire is undetermined, although careless smoking is suspected. Fire department officials had long recognized that the property was a fire trap. A week before they had been able to place a ban on the parking of cars in the abandoned warehouse. Operations of fire boats were hampered by tugs which were tied to the wharf.

There was no loss of life during the course of the fire, but several firemen were injured.

# Fires in Which There Was Loss of Life.

## Second Quarter, 1941.

Reports covering 135 fatal fires have been received by the Department of Fire Record during the second quarter of 1941. Two hundred and eighty-two persons lost their lives as a result of these fires. During this period, seven fires were reported, each of which involved losses of five or more lives. These reports are summarized below.

MARCH 18, 1941, WEST COLESVILLE, N. Y. A man, his wife, and three children were burned to death in their beds when fire destroyed their rural home. The fire is believed to have been caused by an overheated wood-burning stove. (L-06461.)

MARCH 18, 1941, MONTREAL, P. Q. Five men were killed and some sixty other persons, including six women, were injured in an explosion followed by fire which seriously damaged a large fur dressing and dyeing establishment. The explosion resulted from the ignition of gasoline vapors by a spark from a motor. The plant was a brick-joisted structure equipped with automatic sprinklers, but lacking explosion-proof electrical equipment, adequate ventilating facilities to carry off gasoline fumes, and explosion-venting construction as specified in the N.F.P.A. Standards. It is reported that the sprinkler system was crippled by the explosion and collapse of parts of walls and for that reason was of doubtful value in controlling the fire. (S-78746.)

MARCH 24, 1941, WINDSOR MILLS, P. Q. Seven children, ranging in age from eighteen months to thirteen years, were burned to death in a fire of unknown origin which destroyed their two-story wood and stone farm home. The fire occurred while the parents were out visiting. (L-06462.)

MARCH 25, 1941, AT SEA. Nineteen men lost their lives in an explosion and fire which swept the oil tanker *Cities Service Denver*. The explosion occurred when the ship was about 80 miles south of Cape Lookout, N. C. The origin of the explosion was not determined. (H-43993.)

MARCH 26, 1941, AT SEA. Nineteen men of the Royal Canadian Navy lost their lives when the H.M.C.S. *Otter*, a patrol vessel, took fire off Halifax, N. S. The crew took to the lifeboats and the survivors were shortly picked up. Two officers and seventeen men drowned or died of shock and exposure. The cause of the fire was not determined. (H-43994.)

MAY 18, 1941, AT SEA. An explosion aboard the excursion boat *Nightingale* killed seven of the thirty-nine passengers and injured fourteen others. The boat burned to the water's edge about twelve miles off Little River Inlet, S. C. It was reported that in an effort to start a balky engine, members of the crew had been pouring gasoline from a 5-gallon container into soft drink bottles and then poured it from the bottles into the carburetor. Some of the gasoline was spilled in the process and this became ignited in an unknown manner. The blast was pronounced an "unavoidable accident" by a coroner's jury which investigated it. (H-43995.)

MAY 22, 1941, BICKNELL, IND. Fourteen miners were killed by a gas explosion in a coal mine. Seventeen other miners working on the same 325-foot level, but 2500 feet or more from the scene of the blast, made their way to safety. It is reported that they walked two and one-half miles through side passages to avoid gas-filled corridors. (H-43996.)

### Foreign Fires.

Three fatal fires have been reported during the last quarter from non-belligerent countries, outside of the United States and Canada. These fires are not included in the tables, but are summarized below.

MARCH 14, 1941, SANTA BARBARA, SPAIN. A terrific explosion in a powder warehouse devastated "an entire suburb and blasted out doors and windows even in the center of Seville." The fatalities were variously reported at from seventeen to fifty. More than 500 persons were injured and 3000 left

## Loss of Life by Fire, April-June, 1941.*

*This is a typical rather than a complete record, presented to show the conditions under which loss of life occurs, that they may be known and guarded against. The total loss of life by fire in the United States is estimated at 10,000 annually.*

| Occupancy | No. Fires | Men | Women | Children | Total |
|---|---|---|---|---|---|
| Aircraft | 3 | 6 | 1 | 1 | 8 |
| Apartments, Hotels, Lodgings, Tenements, etc. | 17 | 11 | 13 | 4 | 28 |
| Barns and Stables | 1 | 2 | 0 | 0 | 2 |
| Boats and Ships (except Tank Vessels) | 3 | 27 | 0 | 0 | 27 |
| Tank Vessels | 2 | 21 | 0 | 0 | 21 |
| Dwellings—rural | 25 | 14 | 9 | 34 | 57 |
| Dwellings—urban | 33 | 16 | 14 | 19 | 49 |
| Forest and Brush Fires | 5 | 8 | 0 | 1 | 9 |
| Hospitals and Institutions | 4 | 1 | 5 | 2 | 8 |
| Manufacturing Occupancies | 12 | 21 | 0 | 0 | 21 |
| Mercantile Occupancies | 2 | 3 | 1 | 0 | 4 |
| Military Property | 2 | 2 | 0 | 0 | 2 |
| Mining Property | 2 | 16 | 0 | 0 | 16 |
| Motor Vehicles (except Tank Trucks) | 5 | 5 | 1 | 2 | 8 |
| Oil Refineries and Bulk Distributing Plants | 2 | 3 | 0 | 0 | 3 |
| Out-of-door fires | 9 | 6 | 0 | 3 | 9 |
| Piers and Wharves | 1 | 1 | 0 | 0 | 1 |
| Response to Alarms | 2 | 3 | 0 | 0 | 3 |
| Restaurants | 1 | 1 | 0 | 0 | 1 |
| Schools and Colleges | 1 | 1 | 0 | 0 | 1 |
| Theatres | 1 | 1 | 0 | 0 | 1 |
| Other Known Buildings | 2 | 3 | 0 | 0 | 3 |
| Totals | 135 | 172 | 44 | 66 | 282 |

*This table is made up from those reports received by the Department of Fire Record between March 16, 1941, and June 15, 1941. A few of the fires included herein occurred prior to March 16, but were not reported until subsequent to that date.

homeless. The explosion was ascribed to the dropping of a case of explosives by a workman, this blast detonating all the warehouse stores. (H-43997.)

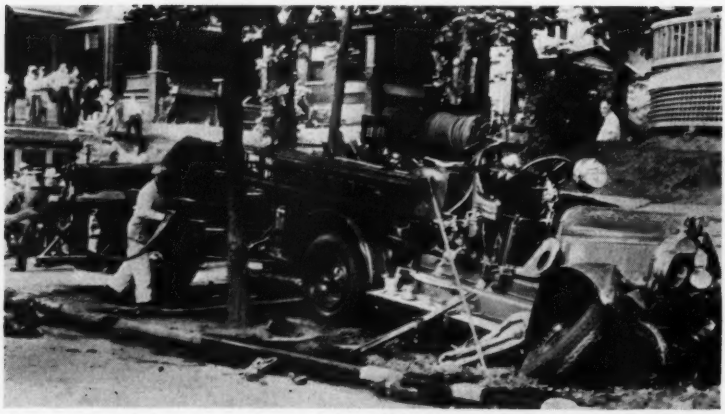
APRIL 8, 1941, SABINAS, MEXICO. At least seven persons were burned to death in a fire which destroyed the Hotel Reforma. Further details are lacking. (H-43998.)

MAY 3, 1941, MANILA, P. I. Three thousand tinder-like native houses were destroyed in a conflagration which caused the death of three Filipinos and left 25,000 homeless. Most of the homes were built of bamboo and thatched with Nipa palm leaf. The origin of the conflagration is not reported. (H-43999).

## Causes of Loss of Life, April-June, 1941.

*Fatalities classified according to the immediate cause of the loss of life rather than according to the cause of the fire.*

| Cause of Fatality | Men | Women | Children | Total |
|---|---|---|---|---|
| Aircraft Fires | 6 | 1 | 1 | 8 |
| Asphyxiation (Smoke and Gas Suffocation) | 5 | 8 | 3 | 16 |
| Children Alone in House | 0 | 0 | 18 | 18 |
| Children Playing with Matches | 0 | 0 | 3 | 3 |
| Clothing Ignited: | | | | |
| 1. Bonfires, Burning Rubbish, etc. | 4 | 1 | 3 | 8 |
| 2. Fireplaces and Open Grates | 0 | 0 | 1 | 1 |
| 3. Furnaces, Stoves, and Heaters | 2 | 6 | 0 | 8 |
| 4. Smoking and Matches | 2 | 1 | 0 | 3 |
| 5. Smoking in Bed | 3 | 1 | 0 | 4 |
| 6. Miscellaneous | 0 | 2 | 0 | 2 |
| Entering a Burning Building | 0 | 0 | 2 | 2 |
| Escaping Fire; Jumped, Fell or Drowned | 2 | 1 | 1 | 4 |
| Explosions: | | | | |
| 1. Acetylene | 2 | 0 | 0 | 2 |
| 2. Dusts | 1 | 0 | 0 | 1 |
| 3. Explosives | 2 | 0 | 0 | 2 |
| 4. Manufactured and Natural Gases | 1 | 0 | 0 | 1 |
| Fire Fighting—Firemen | 5 | 0 | 0 | 5 |
| Fire Fighting—Civilians | 3 | 1 | 0 | 4 |
| Flammable Liquids and Vapors: | | | | |
| 1. Gasoline and Similar Liquids | | | | |
| (*a*) Stoves, Lamps, and Torches | 0 | 1 | 0 | 1 |
| (*b*) Used for Cleaning Purposes | 0 | 2 | 2 | 4 |
| (*c*) Used to Kindle Fire | 1 | 0 | 0 | 1 |
| (*d*) Miscellaneous | 6 | 0 | 0 | 6 |
| 2. Kerosene, Range Oil, and Fuel Oil | | | | |
| (*a*) Stoves, Lamps, and Torches | 1 | 0 | 0 | 1 |
| (*b*) Used to Kindle Fire | 0 | 0 | 1 | 1 |
| 3. Petroleum Production and Storage | 3 | 0 | 0 | 3 |
| 4. Miscellaneous and Unknown | 1 | 0 | 0 | 1 |
| Forest and Brush Fires (including fire fighting) | 5 | 0 | 1 | 6 |
| Indirect Causes (overexertion, exposure, etc.) | 7 | 2 | 0 | 9 |
| Marine Fires | 48 | 0 | 0 | 48 |
| Mine Fires and Explosions | 16 | 0 | 0 | 16 |
| Motor Vehicle Fires (except Tank Trucks) | 6 | 1 | 2 | 9 |
| Response to Alarms | 3 | 0 | 0 | 3 |
| Trapped in Burning Buildings | 33 | 16 | 27 | 76 |
| Miscellaneous Known Causes | 3 | 0 | 1 | 4 |
| No Data | 1 | 0 | 0 | 1 |
| Totals | 172 | 44 | 66 | 282 |



*Acme.*

**Two firemen were killed and eight others injured on May 22, 1941, when these two pumpers of the Kansas City, Mo., fire department collided at an intersection while responding to an alarm. The sirens of both trucks were operating and apparently neither driver heard the other truck approach. It is to avoid just such accidents as this that many fire departments require drivers of apparatus to respond to alarms over predetermined routes. (L-06475.)**

## Typical Fatal Fires.

### Children Playing with Matches.

MAY 2, 1941, WASHINGTON, D. C. A five-year-old colored boy was burned to death in a fire which consumed the interior of his two-story brick home. The child was playing with matches on the first floor and a curtain became ignited. He ran upstairs and hid in a rear bedroom only to be trapped by the flames. His small sister and brother were rescued by neighbors. At the time of the fire, the children were alone in the house. (L-06463.)

MAY 22, 1941, WASHINGTON, D. C. A three-year-old girl was fatally burned when her bed clothing became ignited while she and her five-year-old brother were playing with matches. (L-06464.)

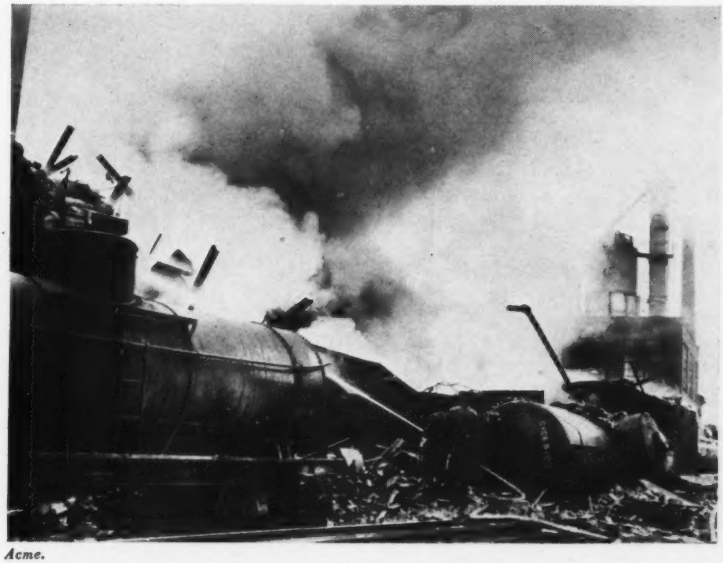
### Clothing Ignited.

MARCH 13, 1941, STATEN ISLAND, N. Y. An elderly woman was burned to death when her clothing became ignited as she was attempting to thaw frozen pipes with hot coals from the furnace. (L-06465.)

MARCH 20, 1941, TEANECK, N. J. A woman died in a hospital three weeks after she suffered severe burns. Her dress became ignited while she was burning refuse in her back yard. (L-06466.)

### Dust Explosion.

APRIL 6, 1941, TORONTO, ONT. One man was killed and two others injured when an explosion leveled a seed cleaning plant in the down-town section of the city. The explosion, which completely demolished the building, is believed to have been caused by the ignition of dust. (H-44006.)



*Acme.*

**An explosion followed by fire killed two men, destroyed the filter house and damaged the near-by wax house of this oil refining plant at Emlenton, Pa. The explosion occurred on March 30, 1941, while oil filters were being cleaned by a process involving the use of naphtha. The loss is estimated at $175,000. (H-44001.)**

### Escaping Fire.

MAY 8, 1941, BOSTON, MASS. A mother and her five-months-old son were killed in a fire which swept through a lodging house. The mother attempted to save her baby by tossing him to persons at a window of an adjacent building, but the child dropped thirty feet to a stone step and was killed. The mother plunged from the third floor window in a frantic effort to grasp the infant. (H-44004.)

### Flammable Liquids and Vapors.

MARCH 13, 1941, MONTREAL, P. Q. Burned on his head and face, a metal worker died in a hospital. The victim was soldering an empty gasoline tank when the torch he was using ignited fumes in the tank. In the explosion which followed, his clothes were ignited and his face and head severely burned before other employees came to his aid and extinguished the flames. (L-06469.)

MARCH 13, 1941, MERKEL, TEXAS. A woman and her two infant daughters were burned to death when their tourist cabin home was destroyed by fire. The mother had been washing clothes with gasoline when the fire started. (L-06470.)

MARCH 26, 1941, PORTER TOWNSHIP, MICH. A woman died in a hospital of burns suffered in an explosion that occurred while she was attempting to remove grease from work clothes with gasoline. The flames which enveloped the woman's clothing spread through the house, destroying it and its contents. (L-06471.)

MARCH 28, 1941, LITCHFIELD, Mich. A ten-year-old boy was fatally burned when he tried to quicken a stove fire with kerosene. (L-06472.)

APRIL 4, 1941, AURELIUS CENTER, MICH. A man was fatally burned and three other persons including a woman and child were critically burned in an explosion of illuminating gas which destroyed their home. The man who died was a gas company employee engaged in repairing a gas leak. The gas line broke during the process, and before he could plug it, the gas became ignited, probably from the fire in the kitchen stove. (L-06473.)

APRIL 28, 1941, LYNCHBURG, VA. A small child was fatally burned in a hospital when an oxygen tent caught fire from a hot plate heater. According to the *Richmond Times Dispatch*, a medical official of the hospital made the comment that "It was one of those regrettable accidents that seem to occur every now and then." (H-44002.)

MAY 12, 1941, PERTH AMBOY, N. J. The captain and first officer of a 150-foot motor barge were fatally burned and four crew members were seriously injured when fire started in the craft a few minutes after it had taken on a 124,000-gallon load of gasoline. Firemen extinguished the fire, but not until the cabin of the barge had been destroyed. The fire started shortly after a member of the crew had turned off a feed valve on the dock, stopping the flow of gasoline from a storage tank. The cause of the fire has not been determined. (H-44003.)

**Smoking.**

MARCH 5, 1941, WASHINGTON, D. C. A woman was fatally burned when she fell asleep on a couch while smoking. When the tragedy was discovered by a maid, the couch was burned to the framework, but the flames had not spread to other points in the room. (H-44000).

MARCH 10, 1941, WORCESTER, MASS. An elderly invalid was burned to death when his clothing and the chair in which he was sitting became ignited while he was smoking. (L06467.)

MAY 23, 1941, MELROSE, MASS. Unable to leave his bed when it caught fire while he was smoking, an invalid died of burns. His cries attracted a neighbor, who called the fire department. Firemen rushed him to a hospital, where he died. (L-06468.)

**Trapped in Burning Building.**

MARCH 30, 1941, DANVILLE, VA. Two men were burned to death when the one-room shack in which they lived was destroyed by fire. The cause of the fire is unknown, but the men lost their lives because of a wire fence surrounding the shack. The fence was in close proximity to the building and when the men rushed from the burning structure they were unable to open the locked gate or to climb the six-foot fence. The fire department arrived to find the shack a mass of flames and the victims dead. (H-44005.)

**National Defense demands better protection to meet this threat**

Today, the employment of adequate protection measures to safeguard against the possibility of business interruption through fire is a vital factor in our national defense effort. For every establishment whose products or services are directly or indirectly concerned with the national defense, or national health and safety, is a logical target for saboteurs.

Against this sinister threat, no establishment can regard its protection as complete unless it includes *automatic* alarm systems to perform the following functions:

1—Automatic detection of unauthorized entry of closed premises, or intrusion upon restricted areas at any time—with instantaneous, automatic summoning of police, or other designated emergency forces.

2—Automatic detection and reporting of attempts to tamper with sprinkler systems, and automatic summoning of the fire department the instant the sprinkler operates.

3—In unsprinklered premises, automatic detection of fire *when it starts*, and automatic notification to the fire department.

4—Automatic summoning of assistance if the watchman's patrol is interrupted by intruders, or for any other reason.

* * *

*A.D.T. Electric Protection Services are available with Central Station Supervision in all principal cities and their adjacent territories. Write to A.D.T., 155 Sixth Avenue, New York, for further information and free descriptive booklets.*

**A. D. T. ELECTRIC PROTECTION SERVICES**

*Controlled Companies of* **AMERICAN DISTRICT TELEGRAPH CO.** *155 Sixth Ave., New York*

CENTRAL STATION OFFICES IN ALL PRINCIPAL CITIES OF THE U.S.

A·D·T

*Electric Protection Services*

AGAINST FIRE · BURGLARY · HOLDUP

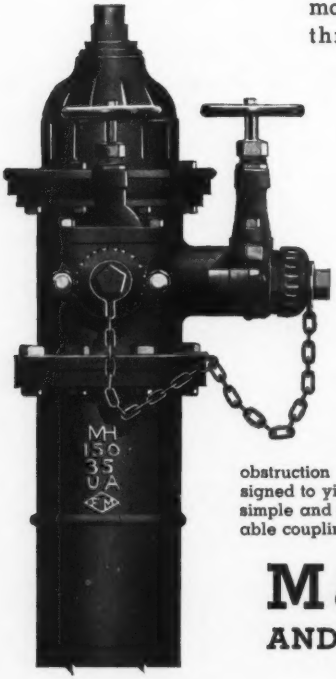
A NATION-WIDE ORGANIZATION

# Fire-Fighters Appreciate

# VALVES
# HYDRANTS

## AND PIPE LINE ACCESSORIES

M & H products are well known for high quality material and expert workmanship. They have been widely used throughout the country for many years. They include several types of Gate Valves, Check Valves, Flap Valves, Valve Boxes, B & S Fittings, Flanged Fittings, Fire Hydrants and many other cast iron pipe line accessories.




### AWWA & UNDERWRITERS APPROVED FIRE HYDRANTS

M & H Fire Hydrants are dry top and revolving head. They are easy to lubricate. Maintenance costs are low due to simplicity of design and rugged construction. They have low friction loss and great efficiency because barrel diameter is not reduced and there are no working parts or obstruction in waterway. Special Traffic model is designed to yield at the ground line under impact. Repair is simple and easy by renewing breakable bolts and breakable coupling on stem.

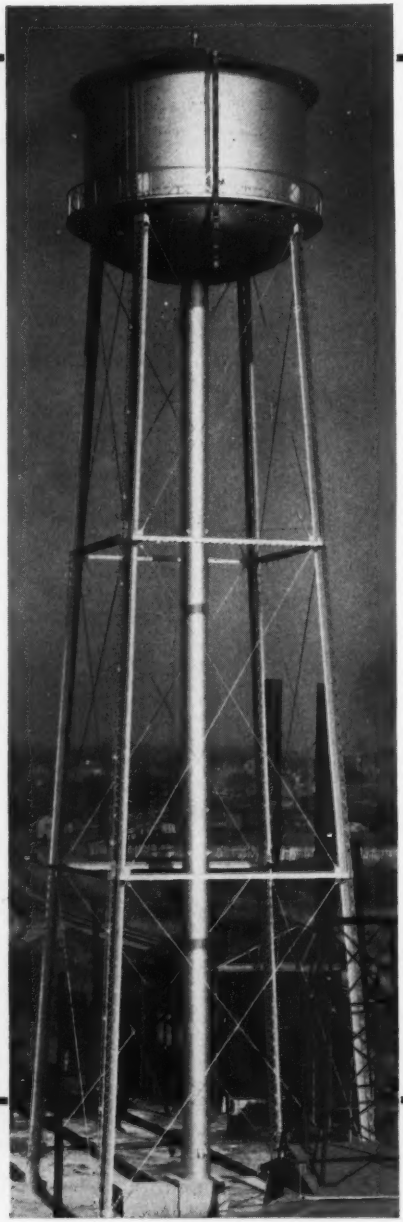
## M&H VALVE
## AND FITTINGS COMPANY

ANNISTON, ALABAMA

# *For Safe Clinical Photography*

**INVOLVING even less hazard than newsprint paper, Eastman Safety Films are as safe as the name sounds. They are available in many emulsions, including those recommended for regular clinical and dental radiography. Eastman Kodak Company, Rochester, N. Y.**

**EASTMAN**
***SAFETY FILMS***



# PROTECT YOUR PLANT FROM DAMAGE BY FIRE

Is your plant working day and night on orders for national defense? Are your fire hazards increased by inexperienced workmen, crowded working and storage space, or overtaxed machinery? If so, you should investigate the fire protection offered by an elevated tank connected to a sprinkler system throughout your plant.

A fire that is just starting is the easiest to put out. If it is done automatically, without depending on human indecision or confusion, there is little chance for the fire to gain headway enough to do serious damage. Elevated tanks are completely automatic because they operate by gravity pressure. Water is stored above your plant, free to flow the instant a sprinkler head opens. The tank can also be connected to hydrants located in your plant yard.

Write for prices stating capacity and height to bottom required.

## CHICAGO BRIDGE & IRON COMPANY

CLEVELAND CHICAGO BIRMINGHAM
DETROIT BOSTON LOS ANGELES
HOUSTON DALLAS PHILADELPHIA
NEW YORK TULSA SAN FRANCISCO

# FAVORITE with Firemen

NONINFLAMMABLE
PYRANOL
TRANSFORMERS

**SAFETY WITH SAVINGS**
Pyranol transformer installed indoors on overhead platform. No vault was needed.

FIREFIGHTERS feel a lot more friendly toward transformers filled with Pyranol—General Electric's noninflammable synthetic cooling liquid for electric equipment. They know these transformers can't add to fire hazards—even if their tanks are ruptured—because PYRANOL CAN'T BURN!

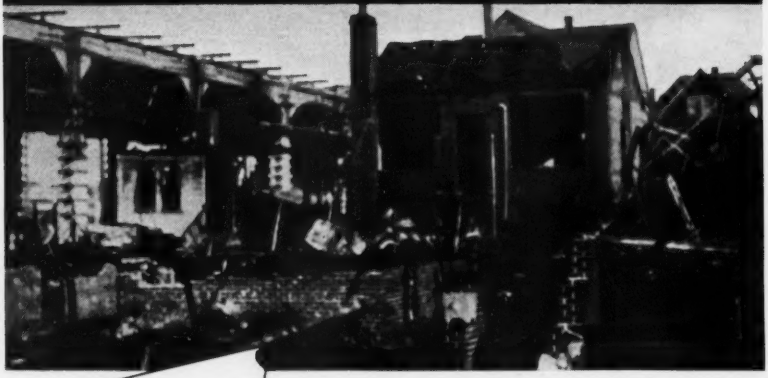
Pyranol transformers can be safely installed right inside your building, *without a fireproof vault.* And the resultant savings in materials often make such installations the most economical as well as the safest.

Find out about noninflammable Pyranol. It provides the low-cost way to put transformers wherever you want them—*with complete fireproof safety.* Call our local office for additional details—or write for Bulletin GEA-2637. General Electric, Schenectady, N. Y.

GENERAL ELECTRIC

402-33-5100

# Flammable Canvas Again Responsible



36

**Fire at Arverne Razes 9 Homes, Kills Resident**

**32 Buildings Are Damaged, 25 Persons Slightly Hurt and Smoke Overcomes 3**

A fire which started at 1 a. m. yesterday at Beach Channel Drive and Beach Seventy-fifth Street, Arverne, Queens, and quickly spread to houses in the vicinity, damaged thirty-two buildings and cost the life of one man, nine of the damaged buildings, dwellings, were destroyed.

loss at $100,000.

The blaze was discovered in the oil-soaked tarpaulins protecting the wooden frame work around concrete stanchions, which will support the overpass of the Far Rockaway branch of the Long Island Railroad when the structure is completed. The railroad right of way crosses Beach Channel Drive at Beach Seventy-sixth Street. Sparks from the canvas and the wood they covered were carried by the wind to nearby structures.

Death, Injury, $100,000 Loss. . . . Another disastrous fire spread by oil-soaked tarpaulins used in building construction.

For a few cents more per yard, these tarpaulins could have been made of FIRE CHIEF Finished Duck—the permanent fire-resisting finish that won't wash out—and this needless loss of life and property could have been prevented.

Wherever flammable canvas presents a fire hazard—indoors or out—from welding sparks, hot rivets, workmen's torches, carelessly thrown cigarettes and matches, or other causes, FIRE CHIEF Treated Duck assures safety.

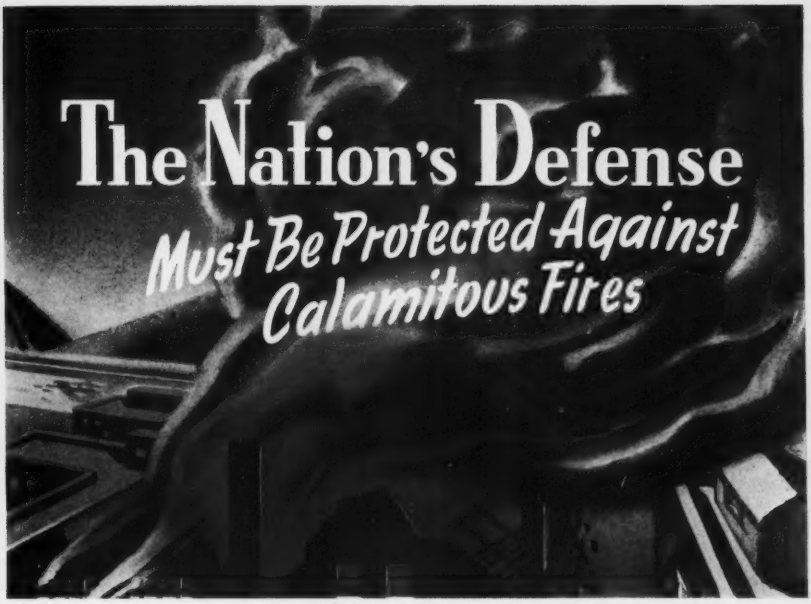
Approved by both the Underwriters Laboratories and the Associated Factory Mutual Fire Insurance Companies, and meets all Government requirements.

**WM. E. HOOPER & SONS CO.**

New York PHILADELPHIA Chicago

Mills: WOODBERRY, BALTIMORE, MD.

**FIRE CHIEF** *The Finish That WON'T WASH OUT*




★ In this crisis of Unlimited National Emergency our defense production speeds ahead in the shadow of a great threat — FIRE!

Defense preparations are, invariably, extreme hazards facing the momentary danger of fire caused by accident or lurking enemy sabotage. Nothing short of all-out fire protection is adequate for any occupancy engaged in maintaining the nation's safety.

Do we count the cost of defense production? Shall we take unnecessary risks by counting too closely the cost of defense *protection?*

Fire Protection Engineers must answer this question in the national interest. Will they base fire protection of our defense on minimum requirements and minimum peace-time cost? Or, will they stand on their sound recommendations for full, absolute protection in the solemn determination that calamitous fires must not occur?

Will they demand that water supply be fully adequate to prevent raging fire? Will they demand that open sprinklers in quantity be ready to discharge a full-fighting deluge of water when emergency strikes? How insignificant are these costs in the face of possible disastrous loss!

*Ask for Bulletin 44 on the*
*Suprotex-Deluge Sprinkler System*

**"AUTOMATIC" SPRINKLER CORP. OF AMERICA**

**YOUNGSTOWN, OHIO** • ***Offices in Principal Cities***

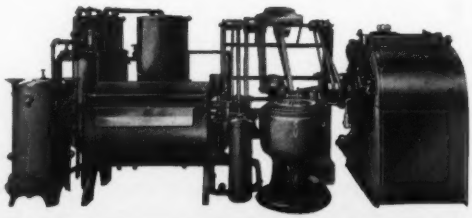
# NEW HOFFMAN DRY CLEANING UNIT SETS NEW STANDARDS OF SAFETY

While we are at all times interested in promoting greater safety in the use of the equipment we sell to the dry cleaning industry we are especially proud of this new development. Here for the first time is a petroleum solvent dry cleaning unit which has been granted listing by the Underwriters' Laboratories, Inc., under their Reexamination Service.

Such listing of course assures fire authorities and insurance rate-making bureaus that 140-F units will be built to specified standards and will be properly inspected.

## USES 140° FLASH PETROLEUM SOLVENT

**The Hoffman 140F dry cleaning unit employs a new solvent with flash point of approximately 140° F. The unit has many unusual features, including a drying tumbler with temperature automatically controlled throughout the drying cycle.**



**U. S. HOFFMAN** MACHINERY CORPORATION
105 Fourth Ave. - New York, N. Y.
EQUIPMENT FOR EVERY DEPARTMENT OF THE DRY CLEANING PLANT

FOR more than a generation this company has furnished cast iron pipe for water supply lines, distribution mains and fire protection mains to cities and towns throughout the United States, as well as for industrial plants, institutions, etc. Most of the largest high pressure fire service systems in this country are constructed of U. S. Cast Iron Bell-and-Spigot Pipe. We furnish pit cast or centrifugally cast pipe in a full range of sizes and various types of joints.

U. S. PIPE & FOUNDRY CO.

General Offices: Burlington, N. J.

Foundries and Sales Offices throughout the U. S.

*Your copy of this bulletin will be sent on request.*

# TYDEN PRESSURE MAINTENANCE

## *. . . an AUTOMATIC device that POSITIVELY maintains PROPER air pressure in the sprinkler system*

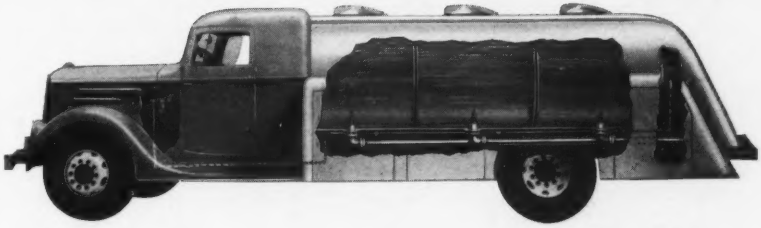
ACCEPTED by insurance underwriters, this TYDEN device is the *only* one available today that maintains positively at all times the proper amount of air pressure in dry pipe sprinkler systems. High air pressure is not only undesirable but is extremely detrimental to the operation of the system . . . the TYDEN Pressure Maintenance Device receives air from any constant source at any pressure higher than maximum required, and automatically delivers and maintains the proper pressure in the sprinkler system. Eliminates possibility of human or mechanical errors. Minimizes claims for fire or water damage. Pays for itself many times in maintenance costs. Talk it over with your VIKING man.

*Representatives in Principal Cities*

# THE VIKING CORPORATION

HASTINGS, MICHIGAN—U.S.A.

# HAZARDS are Increasing



This is one of four different types of S. & J. Internal Safety Valves, available in sizes from 1½ to 6 inches.

**The hazards of highway transportation of inflammable liquids are mounting rapidly as a result of the national defense program — and safety measures are becoming more urgent. It's a long story — but here are the highlights. The shortage in tankers is throwing an additional long haul burden on tank cars, making truck transportation necessary for usual rail hauls. With the greater need for mobility and speed, thousands of military vehicles in the hands of inexperienced drivers—fire and accident hazards are multiplied. Every truck tank used on streets or highways should be equipped with S. & J. Hydraulic Internal Safety valves to protect life, load, equipment and property from fire and explosion hazards incident to collisions and unloading. Write for our booklet, "Transporting Inflammable Liquids With Safety."**

**SHAND & JURS CO.**

**BERKELEY, CALIFORNIA**

**NEW YORK CHICAGO HOUSTON LOS ANGELES**

**SHAND & JURS**

# *See* WATERFOG *in Action!*

## *New Rockwood Movie Shows Graphic Extinguishment of Flammable Liquid Fires*

Now we can show you—right in your own office — the remarkable extinguishment of flammable liquid fires with Rockwood WATERFOG. This has been made possible by our latest motion picture "WATERFOG — MASTER OF FIRE" — a graphic film in *sound* and *color*.

**"WATERFOG— Master of Fire"**
**A new fire protection motion picture...16 mm., in sound and color ... showing time 37 minutes.**

During the recent convention of the National Fire Protection Association at Toronto, this new motion picture made its initial appearance. Several hundred members of the N.F.P.A. who witnessed the showings were enthusiastic about the educational qualities of this new film and its many new and striking features.

"WATERFOG — MASTER OF FIRE" is filled with action. It presents in simplified form the basic story of WATERFOG both in theory and by practical demonstrations. In pictures and words it will show you what WATERFOG is and why it has such remarkable fire extinguishing action.

In this new Rockwood film you will see 38 fires in flammable liquids and other materials — all in actual color. Some of these you will find are the most graphic fire extinguishment scenes that you have ever witnessed. A few of them are masterpieces in color photography.

A number of the actual WATERFOG tests conducted by the Underwriters' Laboratories and the Associated Factory Mutual Laboratories are shown in this new Rockwood film. Other features are demonstrations of WATERFOG Systems of fixed piping, WATERFOG Nozzles and Applicators on hose lines, and the specific applications of WATERFOG for the protection of fire hazards in industrial plants, in the electric power industry and in the oil industry.

If you are responsible for fire protection in your property or if you are a fire insurance official it will be well worth your while to see "WATERFOG — MASTER OF FIRE." Our nearest representative will be glad to show this film to you and your associates without any obligation whatever. Simply write to:

**ROCKWOOD SPRINKLER COMPANY**

*Sprinkler Systems and Fire Protection Engineering*

**WORCESTER, MASSACHUSETTS**

In Canada: Worcester Fire Extinguisher Co., Ltd., Montreal and Toronto

# Protect Industry

**PROPERTY CREATED BY YEARS OF INDUSTRY IS DESTROYED BY FIRE IN AN HOUR as the result of only a slight delay in sending an alarm.**

Three-Fold
Fire Alarm Box

Fire is the greatest destroyer of property, and DELAY due to inadequate facilities for transmitting alarms to the fire department is the greatest accelerator of the flames.

A reliable Fire Alarm Telegraph System with adequate box distribution protects property, gives the fire department a chance to keep losses small, and relieves the community as a whole from the responsibility for fire waste due to DELAYED ALARMS.

Surveys, plans, and estimates furnished without cost or obligation.

## THE GAMEWELL COMPANY

**Newton Upper Falls, Massachusetts**

# *Secret Weapons!*

**Success on the battlefield today is often based on "blitzkriegs" and "secret weapons." Coupled with the elements of time and speed, such methods are usually successful until counteracted by super devices and tactics which overcome them!**

**Success in the daily battle against fire requires no secret weapons! Grinnell Automatic Sprinklers are known throughout the world as the most deadly weapon to combat this ever lurking enemy. For more than half a century they have been on guard, day and night, to stop fire at its source.**

**There is a type of Grinnell Sprinkler System for every fire hazard. Each is designed to provide the utmost in automatic fire protection for specific conditions. Complete information is available for the asking from any of our offices throughout the country. Grinnell Company, Inc., Executive Offices, Providence, R. I.**

**GRINNELL**

**AUTOMATIC SPRINKLER FIRE PROTECTION**